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All correspondence relating to the publication of papers should be addressed to the editor, Abel Wolman, 2411 North Charles Street, Baltimore, Maryland.

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LOST TO HIS COUNTRY . . .
PRINCE ALBERT

BY his untiring efforts as Sponsor of the Great Exhibition of 1851; as President of the British Association for the Advancement of Science; as active patron of the Society of Arts, "Albert the Good", beloved Consort of Queen Victoria, did much to direct the application of science and invention to the betterment of the everyday life of his adopted countrymen

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AMERICAN WATER WORKS ASSOCIATION

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Discussion of all papers is invited

Vol. 27 MARCH, 1935 No. 3

ENGINEERING BUSINESS PRACTICE RELATING TO THE DETROIT ADDITIONAL WATER SUPPLY PROJECT

By Edward W. Frey

(*Principal Construction Clerk, Department of Water Supply, Detroit, Mich.*)

The writer recently completed a book entitled a "Treatise on Engineering Practice relating to the Detroit Additional Water Supply Project," of which only a limited number of copies are available. As its general distribution to those who have manifested a desire to obtain copies is impossible, space in The Journal to cover the most interesting aspects of the book's contents has been offered by the Editor.

ORGANIZATION AND PERSONNEL

The Division of Engineering of the Detroit Department of Water Supply came into existence on January 8, 1924, when the Board of Water Commissioners approved the recommendations made by a board of consulting engineers, who in their report revealed that in the decade 1900 to 1910 there was an increase in the population of the City of Detroit of over 60 percent and that in 1920 nearly three and one-half times as many persons were living within the corporate limits as in 1900. To keep abreast of this situation, it was readily appreciated that additional facilities for the furnishing of clear and wholesome water was necessary and that the then existing equipment must be supplemented with newer and more modern methods of supplying Detroit's water needs.

The first definite step taken was to submit to the citizens a proposal for issuing bonds to the extent of $30,000,000. Having received approval, the Chief Engineer, Mr. George H. Fenkell, by board direction, immediately effected an organization. As the task of selecting a personnel was a matter of utmost importance, in that the work would require men of extensive and varied technical experience, the chief engineer and the chief examiner of Civil Service Commission, Mr. Fred W. Smith, collaborated to such extent as to call for nation wide examinations. In this endeavor they were ably assisted by Dean Mortimer Cooley of the Engineering Division of the University of Michigan. Something over two hundred persons evidenced their desire to compete and over one hundred actually participated in the examinations. Those competing in the examinations came from as far east as Boston and as far west as Puget Sound. The examinations wherever held were identical. All applicants who had attained a passing mark on the written examinations were required to appear for oral interview. At the conclusion of the interview a careful compilation was made of the standings of every applicant after which eligible tests were prepared. It was from these lists, supplemented from time to time by later examinations, that the organization was first formed and later maintained.

As various types of engineering was involved, the Division was divided into four groups. These were known as the River Tunnel Bureau, the Land Tunnel Bureau, the Filtration Bureau and the Power Bureau. A fifth bureau known as the Bureau of Accounts was instituted to handle the clerical and accounting details. The head of each engineering bureau was known as assistant engineer, whose general duties as set forth in the official classification of positions were as follows.

> Under direction, to be responsible for the designing and construction of river tunnels, land tunnels, intakes, filtration and power structures; to develop and supervise office and field organization and perform related work.

The requisitions to the Civil Service Commission for the assistant engineers for the first three bureaus mentioned above stated that the men to fill these positions should be qualified for membership in the American Society of Civil Engineers, and that the Assistant Engineer of the Power Bureau should be qualified for election as a member of the American Society of Mechanical Engineers. The men chosen for the executive positions were as follows: Assistant Engineer River

Tunnels, Torris Eide; Assistant Engineer Land Tunnels, Laurence G. Lenhardt; Assistant Engineer Filtration, Arthur B. Morrill; Assistant Engineer Power, William C. Rudd; Principal Construction Clerk, Edward W. Frey.

Business office administration

The office maintenance and clerical detail were handled by a separate unit of the Division known as the Bureau of Accounts, which was in charge of a Principal Construction Clerk. Under this direction were clerks, accountants, stenographers, typists, janitors, messengers and other similar office employees. This group maintained the general offices, furnished messenger service, kept the stationery supply stock up to the required standard and provided the blue printing service. Telephone switchboard service and filing were entrusted to this bureau as well as the general stenographic service. Both male and female stenographers were employed by the Division. While the female help was in the majority, it was no indication of their preference. In some cases executives preferred male help, due to office conditions, but otherwise either sex was acceptable.

Messenger service consisted of one employee in each of the two main branch offices of the Division. Regular trips were made by messengers between construction field offices, the so-called "pick-up" style of automobiles being provided for this service. After making scheduled rounds, messengers assisted in the blue print room or other similar work, such as delivering mail. Thus they were available for emergency runs. Providing this service at reasonable cost was found a very economical plan, for on this extensive construction project innumerable emergency runs proved necessary. If no messenger service had been provided, it would have necessitated pressing into service a higher priced employee.

Office building maintenance consisted of the usual janitor and night-watch service. A 24-hour schedule was maintained, each man working 8 hours per day. Between the hours of 4:00 P.M. and 8:30 A.M. each employee on watch shift was required to register a "Newman Detex Watchman" clock at stations strategically located through the building.

Method of handling tracings and blue prints

The preparation of tracings and finished blue prints was handled along the lines of any well established drafting office. Assignments

for drafting work were made according to the peculiar qualifications of each draftsman; employees of outstanding ability in certain lines being given that work which consisted of special or difficult design and detail, while the balance was assigned according to the engineer's best judgment. For convenience and standardization, three sizes of tracing cloth were used. These were known as "A," "B," and "C" sizes. The "A" size was $8\frac{1}{2}''$ x $11''$, the "B" size was $14\frac{1}{2}''$ x $20\frac{1}{2}''$, and the "C" size was $28''$ x $40''$. These measurements are trim line dimensions, the actual inside measurements between border lines being approximately $\frac{1}{4}$ inch less. In the determination of these various sizes, particular consideration was given to their reproduction. As many tracings were reduced by the lithograph method in order that they might be combined with the contract documents which were $8\frac{1}{2}''$ x $11''$ in size, it was necessary so to arrange the tracings that after reproduction to a smaller size they would still retain the proper scale. Thus the "B" size tracings were twice the size of the "A" and the "C" twice the size of the "B." Likewise by providing sheets of varying dimensions, it was possible to choose a sheet compatible with the size of the drawing to be made, thereby avoiding unnecessary waste. This tracing cloth was purchased from supply houses, cut to dimension with printed border lines and titles. This method resulted in more uniform drawings and avoided the time consuming factor of inserting this detail by hand. For odd size drawings, ordinary rolls of varying width tracing cloth were available.

For filing purposes for references and for locating prints readily, each tracing had a number assigned. These were determined when the drawing was started. Numbers were assigned according to the particular feature of the project represented by the drawing and were obtained from a chart and index prepared for such purpose. For example, drawings of a general nature bore numbers from 10–00 to 19–99, River Tunnel drawings 20–00 to 26–99, and so on for the other divisions of the work. Prints of drawings were submitted to field and office and other interested parties. The tracings were filed according to number in Lyon Metallic or Hamilton Steel filing cabinets especially designed for horizontal filing. Manufacturers' prints or those given the designation "Foreign Prints" were given a number according to the same system used for departmental filing. Blue printing was done in the Division's own offices and equipment used was one horizontal "Pease" blueprinter and one "Pease" dryer. Except during busy stages, this equipment proved quite successful.

At times some work was sent to commercial houses for which prevailing square foot rates were paid.

Considering all sizes, the Division prepared approximately 6,000 tracings. Of this number, approximately 1,200 were "A" size, 1,800 "B" size and 3,000 "C" size. Foreign prints, or blue prints furnished by manufacturers to show the detail of construction and equipment, totaled approximately 5,000.

Filing correspondence

The filing of correspondence was patterned after the so-called Dewey Decimal System of library filing, all of the major items of the work being divided into groups or classes, each class having an index number. For example, matters of general interest to the Division as a whole were given the number 10; the Intake and River Tunnel 20; Land Tunnel 30; and so on until all major activities were represented. These were further subdivided into divisions, each division being given an integral number following the class; for example 10.0 represented "General and Miscellaneous," 1.0 "Population Studies." In the 20 group, 20.0 represented the Intake System (General); 20.01 represented "Public Relations concerning the Intake System"; 20.02 represented "Correspondence pertaining to Property Damage" and so on, continuing with each of the other groups. The index numbers were further subdivided, sometimes to the third decimal place, depending on the volume of material to be filed under a given number and the amount of classification desirable.

The purpose of the "General and Miscellaneous" class was to provide for indexing and filing of matters applying to the entire project or two or more main structures, or data and information that had more or less general interest and was of value for other structures than the one in connection with which it was compiled or worked out. This plan was followed whenever feasible.

Correspondence was indexed as closely as the subject list permitted. The index number was written in the upper right hand corner, usually by the person receiving or originating the correspondence. It was then sent to the file clerk (who also operated the telephone switchboard) where it was filed in vertical steel filing cabinets, the space in each drawer being divided by folders or spacer cards of bristol board. To assist in filing and locating correspondence, tabs of the folders and spacer cards were of different colors; red representing the class, blue, the integral subdivision of the class, green for the first decimal

subdivision, and yellow for the second decimal subdivision. Each tab was labeled with a typewritten sticker indicating both number and subject.

A master file index book was set up consisting of all the numbers of the filing system and was maintained in one bureau. Likewise, file folders corresponding to the numbers appearing therein were set up in steel letter filing cabinets. Facsimile copies of the master file book were given to all executives and others interested within the Division, who were concerned in the receipt or issuance of material to be filed.

No change in the indexing was permitted unless the person in charge of the master book sanctioned a request for such change. Any changes permitted were first recorded in the master book, immediately after which due notice was given in writing to all persons in possession of facsimile copies. Upon receipt of such notice, they were expected to change their copies accordingly. Thus, both master and duplicate copies remained identically the same at all times. Copies of notices concerning a change in the filing index were also sent to the file clerk, who, upon receipt, would prepare a folder for the files. Upon receipt or issuance of correspondence, the proper file number was written or typed in the upper right hand corner, sometimes by the person handling the correspondence and sometimes by an assistant specially assigned. Material was then sent to the file clerk, who would place same in the proper folder in the order of date.

Over fifty thousand pieces of correspondence were handled by the Division during its existence. Correspondence was filed in standard roller bearing steel file cabinets, the contents of which were emptied at the end of each calendar year and transferred to "All Steel" transfer cases.

SPECIFICATIONS AND CONTRACTS

Most of the construction work of the Division was carried on by contract, only a small proportion being done by direct labor. Nearly all important equipment, however, was purchased directly by the City rather than being included in a construction contract. Thus, a considerable amount of work and responsibility ordinarily assigned to a contractor was in this case assumed by the Division or by the City Department of Purchases and Supplies. The advantage of dealing directly with vendors of equipment, considering the size of

the project, was well worth the extra work involved. It is believed that the extra cost to the city, in engineering and clerical service was less than the overhead percentage that a general contractor would have charged for handling the same work.

The material and equipment so purchased amounted to several million dollars and included boilers, generators, a great many pumps of all sizes, steel and cast-iron pipe and fittings, hundreds of valves, wash water troughs, sluice gates, etc., and in one instance even concrete, sand and gravel. These purchases were placed or erected usually by contract, sometimes under general construction contracts and sometimes under special erection contracts.

Under the controlling legislation, any simple purchase of material or equipment was handled by the Department of Purchases and Supplies on receipt of a requisition from the Division. With minor purchases or standard equipment all necessary information could be written on this requisition form. In other cases a specification was prepared, consisting of from one to fifty typewritten pages. All formal specifications were given distinctive numbers for reference purposes.

Any contract involving labor at the site of the project was usually handled entirely by the Department of Water Supply independent of the Department of Purchases and Supplies. The complete form of contract was prepared by the Division, and included besides specifications, the forms of agreement, general conditions, bonds, etc. Each contract was given a distinctive reference number. While the general rule was to handle in this way any agreement involving labor by the contractor on the job, during the latter part of the work it was found convenient to handle some matters of this kind through the Department of Purchases and Supplies, particularly when the labor after delivery was an unimportant part of the work.

The written specifications to cover purchases through the Department of Purchases and Supplies were prepared by the engineers. Prior to the writing of these specifications, careful thought was given to the quantities and qualities involved. In some cases this required considerable research and preliminary investigation of the products offered by manufacturers or their agents. This method of procedure afforded an opportunity to obtain first hand information concerning the relative merits of similar products within a certain field and likewise the determination of their practical adaptation to the proposed installation. Much assistance in this respect was obtained from the

vendors of material, and through the courtesy extended many valuable suggestions regarding the latest developments were received.

Having reached a conclusion as to the standards to be maintained in any proposed feature, each point was carefully incorporated in the written specifications. Accompanying these were drawings outlining essential details and measurements. Specification or contract books were made up in two styles; those considered minor being merely stenciled sheets with blue prints, while the major or more important jobs were made up in printed form with the detail shown on lithographs.

Construction contracts were handled in much the same manner as specifications, excepting that authority to enter into agreements rested with the Board of Water Commissioners rather than the Department of Purchases and Supplies. Legal advertisements and informal letters acquainting contractors and business firms regarding the letting of contracts were resorted to. The Board prescribed the conditions under which bids were to be received, used its discretionary powers as to the amount of the certified check to accompany each bid and otherwise controlled the issuance and acceptance of contracts, with the assistance of the Corporation Counsel of the City on legal questions. The average contract document consisted of approximately 100 pages. The lithographed reproductions of drawings averaged about 25.

In the course of the Additional Water Supply construction program, the Board entered into 155 construction contracts, the total of the original bid prices of which involved a sum of $19,922, 247.00. The total expended on these contracts to June 30, 1933, was $20,952,849.00. The difference between these figures $1,030,602.00 represents payment for variations in the unit bid, extras, bonus payments and such other additional work as was not anticipated when the contracts were written. The total expenditure under purchase specifications covering material and miscellaneous equipment, was $2,602,100.00 or a combined expenditure for contractural obligations of $23,554,949.00.

Arbitration

Included in the general conditions of each contract were certain articles which provided the method of procedure to be followed, should there be disagreement as to the interpretation of the provisions outlined in the contractual documents. Intended to eliminate costly

and time consuming court litigation, the arbitration clause provided a ready means of maintaining a friendly relationship between the department and the contractor and an orderly proceeding of the work, even though officials of both parties could not see eye to eye on certain phases of the contract. Quoting from the contract documents covering a major contract, the arbitration clause reads as follows:

Any decision of the Board or of the Engineer, where time or financial considerations are involved, shall be submitted to arbitration, upon demand of either party to the dispute.

The Contractor shall not delay the work during any arbitration proceedings, except by agreement with the Board.

The demand for arbitration shall be filed in writing with the Engineer, in case of appeal from his decision, within ten (10) days of its receipt and in any other case within a reasonable time after cause thereof and in no case later than the time of final payment, except as otherwise expressly stipulated in the contract. If the Engineer fails to make a decision within a reasonable time, an appeal to arbitration may be taken as if his decision had been rendered against the party appealing.

No one shall be nominated or act as arbitrator, who is in any way financially interested in this contract or in the business affairs of either party or who is otherwise connected with either party or who is a paid officer or employee of the City of Detroit.

The parties may agree upon one Arbitrator; otherwise there shall be three; one named in writing by each party of this contract, and the third chosen by these two arbitrators; or if they fail to select a third within fifteen (15) days, then he shall be chosen by the president of the Detroit Bar Association. Should the party demanding the arbitration fail to name an arbitrator within ten (10) days of his demand, his right to arbitration shall lapse. Should the other party fail to choose an arbitrator within ten (10) days, then the President of the Detroit Bar Association shall appoint such arbitrator. Should either party refuse or neglect to supply the arbitrators with any papers or information demanded in writing, the arbitrators are empowered by both parties to proceed en parte.

If there be one arbitrator, his decision shall be binding; if three, the decision of any two shall be binding. Such decision shall be a condition precedent to any right of legal action, and wherever permitted by law, it may be filed in Court to carry it into effect.

The arbitrators, if they deem that the case demands it, are authorized to award to the party whose contention is sustained, such sums as they shall deem proper for the time, expense and trouble incident to the appeal and, if the appeal was taken without reasonable cause, damages for delay. The compensation of the arbitrators shall be fixed by the Board. The arbitrators shall assess the costs and charges of the arbitration upon either or both parties.

The award of the arbitrators shall be in writing and it shall not be open to objection on account of the form of the proceeding of the award.

In a number of instances contractors and the Board took advantage of the arbitration clause and accepted the arbitrators' decisions in the manner prescribed. Of all the contracts entered into by the Board, in no single instance was it necessary to resort to a court of law; considering the magnitude of the sum of money involved in the many contracts let, this achievement takes its rightful place in the history of the Division's activities. In this connection, proper credit should be given the Corporation Counsel's Office of the City of Detroit, for it was through their advise and counsel, that many of the protective clauses were written into the contract documents, and it was through their valued co-operation that many technical questions concerning the law were so interpreted as to protect the best interests of the Board.

CONSTRUCTION INSPECTION

Eighty percent of the Division's construction work was done under contract. Realizing the importance of capable and honest inspection for such work, no reasonable expense was spared in providing an adequate inspection personnel. A major portion of the work was under the immediate supervision of a field engineer, who was assisted by a surveying field party and a number of inspectors. Such men were acquired through Civil Service channels after they had successfully passed extensive examinations regarding their ability and fitness to perform the required duties. As in other lines of work, it was found that certain of these employees possessed qualifications which made them peculiarly fitted for particular kinds of inspection. As these qualifications became known, assignments were made accordingly, the more experienced and capable men getting the responsible assignments, while the less experienced would be placed in positions of a less exacting nature.

The inspection service consisted of varied and many assignments and, as occasion demanded, the men were given special instructions as to a correct interpretation of the specifications regarding important items of the work. On occasion, inspectors were given a course of instruction in the laboratories of the Division so that policies and decisions might be uniform. As each major construction activity was based upon stringent specifications wherein the acceptable limits of each item of construction were clearly defined, all members of the inspection force were expected to be well informed of the contents of the contract documents and to insist on strict observance to the condi-

tions and terms therein set forth. While common sense and reasonableness was the basis for dealing with the contractor's employees, no deviation from the strict letter of the law was permitted unless with direct consent of the inspector's superior. In other words, the inspectors were given instructions to exercise their best judgment and to maintain a friendly relationship between the Division and the Contractor, but under no circumstances were they given carte blanche authority to make their own interpretations of such vital questions as would warrant an engineer's decision.

When a difference of opinion between inspectors and the Contractor's force on matters of minor nature arose, the matter was brought to the Assistant Engineer for disposal. Any major change in the specification required a resolution of the Board.

CONSULTANTS SERVICE

Whenever conditions arose which required independent engineering, architectural or other technical service, the Board of Water Commissioners engaged consulting specialists. In some cases this was because it was felt advisable, considering the magnitude of the work, to have the best available independent advice in the making or reviewing of particularly important decisions. In other cases, such as architecture, geology, foundation research and landscaping, the work was so specialized or of such a temporary nature that it would have been impracticable or impossible to secure the necessary expert service through the regular salaried organization. Even in matters which the regular staff was entirely competent to handle, the rush of other work often made it advisable to turn over special parts of the work to outside organizations.

In relation to the total cost of the project, the consulting engineers' fees represented an expenditure of a trifle less than 2 percent. Included in this sum were the wages paid draftsmen and other engineering services recruited through the consulting engineering firms or other sources.

WEEKLY LUNCHEONS

At the beginning of the time when the engineering organization started work on this project, the Chief Engineer inaugurated weekly luncheon meetings, which he attended, together with the architect, the Assistant Chief Engineer, and the four assistant engineers. The purpose of these meetings was to establish friendly working relations

between the various bureaus of the Division of Engineering, and to give the engineers an opportunity to exchange views on the engineering problems which arose on the work. Quite frequently final decisions were determined as to the policy that was to govern all bureaus of the Division of Engineering.

These luncheon meetings were held in the engineering office at Water Works Park, Belle Isle or Springwells. Each one attending these meetings was expected to present his views as to problems in his field, when these affected the work outside of his bureau, and when a matter of policy was to be decided.

Each assistant engineer was in charge of a bureau, and was responsible for the work involved with that bureau. Discussion at these meetings included the standards to be used, personnel problems, methods of inspection, preparation of specifications and contracts, arbitration procedure, progress schedules, supervision details and design and construction details.

On occasions, the contractor's representatives were invited to discuss major points of difficulties, which could not be satisfactorily adjusted by the field engineers. The lunch served at these meetings was usually prepared by one or two members of the stenographic force of the engineering office. The attendance varied from six to twelve people, and often included invited guests.

As a means of adjusting the problems of the day, these luncheons proved quite successful and tended towards maintaining more harmonious relations between the engineers, architects, and their associates.

ACCIDENTS

Accidental injuries to employees of the Division were diversified and for the most part minor in nature. It is most regrettable, however, that this manuscript must record three accidental deaths, which occurred in the official family of the employees. The first serious accident resulting in death occurred Friday, October 7, 1927, at 6:55 A.M. An employee, John Meldrum, Inspector of Tunnels, entered the north cage of what was known as Section No. 5, of the Land Tunnels. Mr. Meldrum entered the shaft elevator to go down to the tunnel proper, in the regular course of his duty. Upon the signal to lower being given, the cage dropped to the bottom with a crash, without the cable breaking and apparently with but little restraint on the cage. Mr. Meldrum was badly hurt in the 80 foot

fall, having suffered major internal injuries, which later resulted in his death. Although immediate and drastic investigation was made, it was quite impossible to ascertain the real cause of his accident.

On October 15, 1929, an accident occurring at the Springwells reservoir site resulted in the death of two laborers, Francisco Chipanelli, age 26, and Tony Scarlini, age 38. Both of these men, in company with other employees, were attempting to stop a flow of sulphur water located at the bottom of a twenty-five foot pit. In the performance of their duty, they became asphyxiated from hydrogen sulphide gas, which at the time was not known to exist in the area of the excavation. Much display of heroism was manifested in this sorrowful tragedy and due credit in this respect must be given Clarence Nacker of the Wood Construction Company and Philip Toretta, John R. Scheel and Louis Garavaglia, employees of the Board, each of whom willingly staked his life in the interest of his fellow workmen.

Although the foregoing represent the only casualties among Board employees, one other major accident occurred. This was during the drilling operations of R. S. Morrow & Son, Contractors on the tunnel being driven beneath the Detroit River. In this case, six of the contractors' workmen lost their lives, due to a premature ignition of dynamite, while blasting through the rock. In addition to those killed outright, several employees were badly injured.

As a protection for its employees, the Board retained under contract the services of a competent physician and surgeon. While this physician did not devote his entire time to the Board's activities, he was required to be available at all times for the treatment and care of any and all employees who suffered injuries as a direct result of the work. In addition, he examined from time to time such employees as were assigned to work under air pressure.

On the River Tunnel Work, the Board in conjunction with the contractor, maintained a first aid station to give immediate aid to such accidental injuries as arose. This station was under the supervision of hospital internes chosen by the Board's physician. While the Board paid them for their services, they were directly responsible to the physician. The offices were maintained during such hours as corresponded with the working hours of the contractor, the cost of operation being divided between the Board and the contractor, according to provisions which were embodied in River Tunnel Contract.

Losses suffered through injury or death in the Water Department's

forces were adjusted according to the workmen's compensation laws of the State of Michigan.

PRELIMINARY TESTS AND EXPERIMENTS

Although the major part of the general design of the Additional Water Supply System was based on the generally accepted practices of the water works engineering profession, there were times and occasions when new methods were introduced. These usually involved proposed design and innovations or improvements which were more or less a departure from the usual standard or otherwise unproven insofar as their practical application was concerned. Likewise tests were conducted to determine whether or not equipment and materials to be furnished compared favorably with the conditions stipulated in the specifications and contracts covering such work. Some of the major experiments and tests conducted by the department were as follows:

Arch tests on brick and concrete sections for the tunnel design; bearings to determine soil conditions for tunnel routes; test pits and rail loading tests to analyze foundation conditions for structures; loading tests to determine the supporting powers of friction piles, studies of the hydraulics of filter sand and underdrain piping; experimental coagulation basins; hydraulic models and tests were also made for the Intake Lagoon System and surge conditions.

The Division at all times maintained field and shop supervision, so that constant check could be made of the equipment while same was in process of fabrication. Prior to the manufacture of the large pumps used in the plant, the manufacturer built scale models. Tests of these models were witnessed by officials of the Board.

DEPARTMENTAL ACCOUNTING

The plan for the Additional Water Supply System in a general sense consisted of an intake in Lake St. Clair, a tunnel under the Detroit River to the mainland, land tunnels to the extent of 10½ miles reaching from east to west across the City, with pumping plants, a filtration plant, reservoirs, etc., at the extreme end. In addition, the plans called for many improvements to the existing system.

How to standardize these various jobs and designate them in simplified form and yet arrange them so that they might be easily recognized in field or office, by old or new men, was the first task which confronted the Bureau of Accounts. It was recognized in the

beginning that designation by title was too cumbersome for reporting purposes. The system selected was an extension of one previously adopted by the Michigan Public Utilities Commission and already in use in the Department of Water Supply. Under this system the account number 359 indicated "Unfinished Construction" and nearly all of the work of this Division come under this head. Having thus established a base number which represented new or unfinished construction, the next procedure was to add a second number which would be symbolic of a particular construction activity. Thus, as each new job arose, a number was assigned and thereafter such number represented this particular job until its completion. As each major construction job was broken up into various operations, each operation, therefore, had a number assigned to it so that finally each job was designated by a series of three numbers, the first typifying new construction, the second signifying the feature, and the third being symbolic of the operation. To avoid confusion, each number was separated by a hyphen thus: 359-114-0. A representative series of accounts follow:

	Job key number
Filtered Water Reservoir No. 2 (General)	359–114– 0
Earth excavation and backfill	359–114– 1
Earth excavation placed on site	359–114– 2
Timber piling	359–114– 3
Reinforced concrete Class A	359–114– 4
Reinforced concrete Class B	359–114– 5
Reinforced concrete Class C	359–114– 6
Reinforced steel in place	359–114– 7
Special castings	359–114– 8
Miscellaneous steel and iron	359–114– 9
Placing valves, etc	359–114–10
Etc.	Etc.

Since the number "359" represented new construction work, it was immediately distinguished from other jobs having no relation to the new Additional Water Supply System. The second number "114" in this case indicates the "Filtered Water Reservoir No. 2", while the third number indicates the particular operation.

The accounts identified by such numbers were used for cost keeping. Payments to contractors, salaries and wages of employees, payments for material, office operation costs, and all other expenditures were distributed as charges to these accounts. It was found to be very important to have, in the cost accounting system, just the right

amount of subdivision of each major feature. If there was too little subdivision, for instance, if all the cost of an important contract were kept in a single account, the results would be of very little use. On the other hand having too many accounts made the distribution of charges and the carrying of all the accounts very laborious. The value of the results was in some cases found to be out of proportion to the amount of work involved.

The second number of the three indicated often, but not always, all the work covered by a single contract, amounting to from $100,000.00 to over a million dollars. In some cases, if the contract was on a unit price basis, the subdivisions of the accounting system were made to correspond to the items of the contract. The third number in the job key number was then made identical with the contract item number. In the table above, for example, timber piling was Item No. 3, of the contract, reinforcing steel was Item No. 7, etc.

As new projects were conceived by the various bureaus, request was made to the Bureau of Accounts for a number assignment to cover each job and its various component operations. It was a rule rigidly adhered to that such requests be presented in writing so that under no circumstances would a number come into being without due process of record in the Accounting Bureau. Immediately after such request was received, the Accounting Bureau would officially set up the job designation numbers and likewise establish a cost ledger page in which each item of expense was entered as it developed during the continuation of the work.

The assigned number would also be recorded in which was known as a master classification or account key number. This book consisted of loose-leaf pages 8½-inches by 11 inches in size and was so arranged as to permit the addition of new sheets as occasion arose. Facsimilies of these amount classifications were issued to all key men in field and office for guidance when making charges. From time to time as new work developed and additional sheets were added to the master classification book on file in the accounting office, duplicate copies of such sheets (usually in mimeographed form) were made and issued to the key man possessing copies, with the request that their books be changed accordingly. Under no circumstances were changes allowed to be made in field classifications without written notice having been received from the accounting office. This enabled the office at all times to have absolute control of any and all key numbers applying to the work of the Division.

CONTRACT COST ACCOUNTING

An unusual if not unique method of accounting was employed in securing cost information concerning work done by contractors. In the days before the Additional Water Supply project was initiated, the Board had occasion to lay pipe lines under contract. From this experience it was found that many complications can arise through the letting of work to outside interests and not the least of these was the failure to have sufficient and adequate data concerning the contractor's costs. Having in mind that claims for extra work, lawsuits, forfeiture, liquidation and even bankruptcy on the part of a contractor were not remote possibilities, considering the many ramifications of the work and the vast sums of monies involved in contract work, the Chief Engineer was insistent that ample information concerning the contractor's costs be made available. To do this in an intelligent and systematic manner, not only required the utmost in tact and diplomacy, but it likewise involved a system of record keeping that was outside the usual standards of accounting.

To maintain cost records of one's own work, when all expense in connection with the same is readily ascertained from invoices and other like sources is not conceded to be a difficult task, provided the system of bookkeeping in use is in accordance with universal practices, but to go into the private cost records of a contractor and from them determine what he considers trade secrets, was looked upon by most persons as being quite impossible; still this was accomplished in a highly satisfactory manner and without in any sense of betraying the confidence of the Contractor.

In setting up the system for obtaining Contractor's costs, simplicity was the watchword, as it was readily understood that to initiate an involved or intricate system would entail too large a portion of the field men's time and otherwise antagonize the Contractor's forces through whom much of the information was to be obtained. After some consideration of the manner in which the costs were to be secured, the conclusion was reached that Board's field engineer in charge of construction was the most logical man to record the cost of the Contractor's operations. In order that his authority in this respect might be properly backed up, a clause was included in each contract which read as follows:

> All books and accounts kept by the Contractor in connection with this contract shall be open to the inspection of the Chief Engineer or his properly accredited representatives.

The Contractor shall furnish the Engineer reasonable facilities for obtaining such information as he may desire respecting the progress and execution of the work and the character of the materials, including all information necessary to determine the cost of the work, such as the number of men employed, their pay, the time during which they have worked on the various classes of construction, the cost of repairs to machinery and other information required by the Engineer. The Contractor shall on request, furnish the Engineer with copies of expense bills for transportation charges on all machinery, material and supplies shipped to or from the work under this contract.

Ordinarily, corporations and other private business firms are content to solicit bids for work and let same to the lowest bidder. Thereafter, their chief concern is to demand close adherence to specifications for which the Contractor receives pay in accordance with the contractual agreements. While the Engineering Division was likewise concerned in value received on its contracts, it went a step further to protect its interests. Based on the belief that a contractor's ability to successfully complete a contract was only as good as his financial status during the period of construction, the department maintained what was known as a "Contractor's Cost Record," the purpose of which was to keep a running account of his costs. Because all of the Division's contracts contained provision for taking over the work, should the Contractor fail to carry out his part of the agreement, it was deemed advisable to have a reasonable knowledge of his work and his cost should he default Likewise, it was of value to have such information in the event the Contractor should contest his contract through the courts or by arbitration. Were the department to protect its interests to the fullest extent, surely it was necessary to have facts and figures available to refute or affirm such testimony as might not be comparable to the true conditions. The system also provided a means of obtaining valuable data used in the preparation of preliminary estimates of the cost of proposed work. Considering the wide field of benefits which can be derived from a cost system of this kind and considering also that not one contractor resorted to a court of law, even though the total amount of contracts involved, was well over $22,000,000, it is felt that the institution of a contract cost record was a good investment.

PROBLEMS OF WATER WORKS SUPERINTENDENTS

SOME EQUIPMENT USED IN MAINTENANCE

By G. G. Routledge

(*Superintendent, Water Distribution Section, Toronto, Can.*)

VALVE OPERATION WITH TRUCK MOTORS

Valve operation with truck motor is effected by replacing with a pair of bevel gears, the counter shaft spur gears in a Warford transmission case installed on a 1½-ton Model A Ford chassis so that a power take off shaft driving an idler shaft rotating in the opposite direction are both brought outside the left channel iron of the chassis.

Connection between the ends of these shafts and the operating square of the valve is made through a telescopic horizontal shaft with a universal joint at each end, driving a worm and gear, housed in a grease tight case, connected with a key sliding in a keyseat the full length of a vertical shaft placed on the operating square of the valve.

The outer end of the power take-off shaft is brought within a 6-inch diameter circle about three feet from the vertical shaft which has already been placed on the operating square. A valve requiring about 300 turns to open or close can be operated in about five minutes with this equipment.

The keyseat in the vertical shaft makes possible the operation of valves with squares varying in depths from 2 to 6 feet from the surface.

A counter indicating the number of turns is attached to the vertical shaft and gear case and is visible from the truck driver's seat.

This equipment has been used for the operation of large valves in Toronto since 1922.

PUMPS

The motor truck power take-off shafts are also used for operating centrifugal pumps which are required in connection with the maintenance of the distribution system and occasionally other services.

A 6-inch Beatty pump, which weighs 460 pounds, is placed on the

ground and operated with a shaft with a universal joint at each end connecting the power take off shaft with the pump shaft. This pump has a capacity of about 800 Imperial gallons per minute with a 20 foot lift.

A 4-inch pump, weighing 142 pounds, is supported in position on the side of the truck by brackets and has a capacity of about 600 Imperial gallons per minute with a 20 foot lift.

One 3-inch pump, weighing about 60 pounds, is placed immediately in front of the truck motor and operated directly off the crank shaft, and has a capacity of about 250 Imperial gallons per minute with a 20 foot lift.

Two 1½-inch Elrick centrifugal pumps operated with a rotary air motor have capacities between 60 and 120 Imperial gallons per minute and are used principally for the removal of water required in connection with drilling for the installation of water services. Air for the pump motor is supplied from the compressor which operates the drill.

Diaphragm pumps, weighing with skid mountings about 275 pounds and having a capacity of about 40 g.p.m. when steadily operated, are generally used in Toronto for ordinary repair jobs.

Compressed air supplied by portable compressors with a capacity of 100 cu. ft. of free air per minute is frequently used to remove water from mains; the water being discharged through fire hydrants if suitably located or through special connections.

SERVICE PIPE INSTALLATION DRILL

Water services in sizes up to and including 2-inch are generally installed with a short twist drill operated by a 2½ horsepower air motor at about 200 r.p.m. mounted on an iron frame about seven feet in length and 11 inches in width. This equipment has been in use since 1926.

The drill shaft is made in 4-foot lengths of heavy 1½-inch iron pipe, connected together as required with stout V threads at the ends.

Water supply to the drill point is usually obtained from the service connection on the main through garden hose to the stuffing box around the shaft connecting the air motor to the drill shaft and thence through the latter to the base of the drill point where it is discharged to the cutting edges of the drill through two ¼-inch holes, one on each side of the shaft, drilled as nearly as possible parallel to the centre line of the shaft.

This equipment is used for the installation of water services, excepting where gravel or ground containing numerous boulders is encountered, and has been found very satisfactory.

Cuts in the pavement and interference with vehicular traffic are, to a large extent, eliminated by the use of this equipment.

EQUIPMENT FOR CUTTING LARGE PIPES

Pipes in sizes of 20- to 36-inch in diameter, inclusive, are generally cut with parting tools operated by a worm gear sliding around a ring secured to the pipe with set screws. The parting tools are automatically fed with a star and screw attachment.

The gear is driven by a worm attached to a $2\frac{3}{4}$ horsepower air motor with a speed of about 200 r.p.m.

The air is supplied by a portable compressor. The time required to cut a 24-inch pipe is about 40 minutes, and a 36-inch pipe about one hour.

LEAK LOCATING

Underground leaks which do not flow to the surface can be located by traversing the lines of water mains in the early mornings of Summer and Autumn when there is a damp atmosphere. On such mornings for an hour or two, there will be a damp spot on the pavement or sidewalk immediately over the point where a leak exists.

Up to the present, an investigation at such points has always resulted in the location of a leak immediately below.

TESTING DOMESTIC WATER METERS FOR LOW RATE OF FLOW AND ITS EFFECT ON REVENUE

By T. Hodkinson

(Waterworks Distribution Superintendent, London, Ontario, Can.)

At one time the chief consideration of those contemplating the installation of water meters was the life of the meter. It has come to be realized that the question of life is relatively unimportant compared with that of the frequency of testing and adjusting. Most good meters will last indefinitely or until they become superceded by improved design, but all meters to fulfill their proper function require frequent tests and adjustments.

Mr. Emil Kuichling said some years ago that a thoroughly service-

able meter should have great sensitiveness, but need not have a high degree of accuracy. Manufacturers have been tardy in recognizing this fact, but have recently concentrated on producing a meter of greater sensitiveness. However, no matter how well the manufacturer does his job in this respect it is waste effort if the waterworks superintendent does not by test and adjustment maintain this sensitiveness.

How often a meter should be removed for testing is a much debated question and is one which cannot be answered definitely. The quality of the water is a local condition and is an important factor. The quantity of water passing through the meter, as well as the maximum demand thereon, are considerations of importance. The maximum demand is not usually given sufficient consideration, but no meter should be installed where the maximum demand exceeds 90 percent of its rated capacity. Usually some simple tests may be made by opening valves and taps on the consumers' promises to determine the capacity of the meter required, but frequently with larger installations a graphic recording register (which at least one manufacturer can now supply) is necessary to determine with any degree of accuracy the size of meter. This device, by the way, will also be found most useful for investigating complaints of high bills. Experience shows that meters are fairly accurate throughout a long life at their rated capacity or even at one-half or one-quarter their capacity, but the loss from under-registration quickly becomes serious at low rates of flow.

The question may of course be asked, "Does much water pass through meters at low rates of flow?" If one will consider the number of continuous dribbles at defective ball cocks, Douglas balls, valves and faucets, no other answer is necessary, but in these days there are many other appliances in continuous use such as small ice machines, air conditioners and aquaria which use relatively large quantities of water at very low rates.

In order to obtain as much revenue as possible from these sources all meters in London must show 75 percent accuracy on a flow as low as 2 imperial gallons per hour. These tests are made with meters in series, the water passing through an orifice and the pressure held by a pressure regulating valve at 55 pounds. If the pressure is raised to 65 pounds and the same orifice, $\frac{1}{64}$-inch, used the accuracy will usually rise to 85 or 90 percent due, of course, to the greater discharge.

Such requirements are incorporated in the specifications for new meters now purchased.

In order to show how the sensitiveness of meters diminishes with time the records show that 1000, $\frac{5}{8}$-inch meters removed for test in 1926 after ten years service gave the following results:

PERCENT WITH NO REGISTRATION	ORIFICE SMALLER THAN
	inches
25	$\frac{1}{32}$
50	$\frac{1}{16}$
20	$\frac{1}{8}$
5	$\frac{1}{4}$

These tests were made prior to installing a regulating valve, and the pressure probably averaged 65 pounds.

In spite of the poor showing made by these meters on the small flows they averaged between 97 and 100 percent accuracy on full flows. The test period for all $\frac{5}{8}$-inch meters is now not more than 5 years. That this period is the limit for smaller meters was demonstrated by tests made under working conditions. A $\frac{1}{64}$-inch orifice leak was set up in an employee's residence and meters which had been in service 5 years were installed in series with a check meter, with the following results:

#1. Test over a 7-day period:

		gallons
3 meters	Check meter register	587
	No. 2 meter register	281
	No. 3 meter register	475

#2. Test over a 7-day period:

4 meters	Check meter register	513
	No. 2 meter register	468
	No. 3 meter register	500
	No. 4 meter register	481

In the first test the check meter showed over 100 percent more than No. 2 meter and a loss of 306 gallons per week, or $3.02 per annum. If only 5,000 meters out of the 18,250 domestic meters in use were in this condition there would be a total loss due to under-registration of low flow of over $15,000.00 per year, or if the meters were all in as good condition as the check meter 80,000,000 gallons of unaccounted for water would then be registered on the meters.

A special case may be interesting as it shows the quantity of water and revenue which may be lost because of a small flow. An old $\frac{5}{8}$-inch meter, properly overhauled, was installed on a $\frac{1}{4}$-inch line feeding an air conditioner to which the water is supplied through a $\frac{1}{64}$-inch orifice, in fifty days 2800 imperial gallons were accounted for on this meter, or an average rate of $2\frac{1}{3}$ gallons per hour. The revenue previously lost on this service amounts to about $4.00 per year.

By the end of 1925 all consumers' services in London were metered. It was at this time that the systematic testing and adjusting of meters was seriously taken up. The results of this effort are reflected in the following table:

YEAR	PERCENT OF PUMPAGE RECORDED ON CONSUMERS' METERS
1926	58.7
1927	61.4
1928	62.1
1929	63.0
1930	64.0
1931	65.4
1932	67.2
1933	69.0

It is evident from the above figures that there has been a gain of over 10 percent in the unaccounted for water. As most of this gain was made on domestic consumers' bills, approximately $30,000.00 a year has been added to the revenue or $1.66 per meter.

The average cost of removing, testing and repairing a meter is under $1.50, or for a five year period less than 30 cents a year. If this effort produces an average increase of $1.66 per meter per year in revenue surely it has been demonstrated that this work is worth while.

The late Allen Hazen said,

> It is obvious that testing meters, especially domestic meters, at low rates of flow, goes to the heart of the under-registration problem. Testing meters at ordinary rates of flow has been brought to a state of perfection where little can be suggested to improve it, but testing meters at low rates of flow has been neglected.

It is essential, of course, that in making these tests proper equipment must be installed for the purpose, and it is the opinion in many quarters that it costs too much to remove meters from the consumers'

premises for testing and overhauling. The foregoing experience should show, however, that frequent testing of meters is a source of profitable revenue to the waterworks department. It should also be borne in mind that it probably costs much less to repair a meter two or three times before it is badly worn out, than to allow it to run down to a state when many new parts are required.

The common practice of grinding disc pistons to fit measuring chambers is not recommended. Disc pistons or balls can be purchased from the manufacturer in over-sizes of a thousandth of an inch or more, or if the shop is not properly equipped to fit new parts it would be better to send the chambers to the factory.

In conclusion, I should like to take the opportunity to thank the Canadian meter manufacturers for the great assistance and coöperation they have given in an effort to solve the problem of under-registration of meters at low rates of flow.

AUTOMATIC CONTROL OF DEEP WELLS AND ELECTRICITY IN THAWING FROZEN WATER PIPES

By A. G. Peirson

(Superintendent, Public Utilities, Weston, Can.)

Many superintendents in charge of a small waterworks system, serving possibly a town of 5000 to 8000 of a population, desiring to give efficient service, and at the lowest possible rate for water for domestic and industrial use, have had to solve many a problem to show a profit on his yearly operation.

From 1911 until 1932 Weston was supplied with water from a filtration plant, situated just one mile north of the town, the supply of water being taken from the Humber River. The water was first pumped into two sedimentation basins, and afterwards through two triplex pumps, then chlorinated and filtered, and to a standpipe, from which point it was delivered into the distribution system.

Two attendants were engaged to operate the plant, and were in charge for eighteen hours daily.

Through a system of automatic controls, the plant was operated for the remaining eight hours daily without an attendant on duty.

The automatic control was capable of starting up one pump, delivering 400 gallons per minute, and at the same operation the control would throw in the chlorinator and coagulating equipment, as

well as a Nuchar arrangement which fed its solution in just ahead of the filters. The attendant last on duty had to make sure everything was in order when he went off duty.

In 1932 we changed over from the old filtration plant to two deep wells, each equipped with a 50 H.P. vertical type motor, and pump, capable of delivering 500 gallons per minute against a 212 foot head. These wells are situated 500 feet apart on a five acre lot, three miles from Weston, and at an elevation of 58 feet above the highest point in the town.

Our deep well development has cost us already $57,000.00, the carrying charges on which amounts to about $5000.00 yearly.

The water is absolutely pure, at 44 degrees, and does not require treatment of any kind. We pump directly from the wells into the distribution system.

AUTOMATIC CONTROL SYSTEM

We installed an automatic control system to operate the Deep Wells, and which has been in operation since September 15, 1932.

In order to maintain a desired pressure over the system, we installed a pressure regulating valve in a station erected close to the standpipe. This valve is so set that we secure a pressure of 70 pounds over the system when the well pump is operating, and between 60 and 70 pounds when the pump at the well is off and the booster pump in the station near the standpipe is operating.

By means of an altitude gauge and regulator, the deep well pump operates when the level in the standpipe has reached a certain set point, and then when the standpipe is full of water, the controls shut off the deep well pump, and with the same operation start up the booster pump which takes its supply from the standpipe, and builds up the standpipe pressure of 35 pounds to 60 and 70 pounds, operating until such time as the level has been reduced in the standpipe to 60 feet, or whatever level you may wish the altitude to operate. This cycle continues daily, without any one in charge of the operation. One man only is required to visit the wells once a week to check up on the automatic lubricating system, and record venturi meter records, and draw-down data.

The automatic system is so arranged that by means of a double throw switch, we can use either wells on the automatic control, and we alternate weekly from No. 1 to No. 2 well.

Should we require additional pressure, say 100 to 110 pounds and

1000 gallons per minute, operating two pumps, we can by means of several remote 110 volt switches located at the office, Booster Station, and Superintendent's residence, the second well can be operated at will without going near the wells. This remote control feature is also operative on either well and is put in service by means of the same double throw switch arrangement at the well, that is, if No. 1 well is on automatic control, No. 2 well can be operated at any of the remote control points, and when No. 2 well in on the automatic control circuit, No. 1 well will respond to the remote control system. Pilot lights are placed at each remote control point so that we know at all times, just which pump is operating.

The arrangement of pressure regulating valve, booster pump, and automatic controls, and manually operated controls, tied in with two deep wells, located three miles, distant, and which has given excellent satisfaction, was designed in our office in 1932, and is, we think, something entirely new in connection with automatically controlled deep wells water supply systems.

It might be of interest to state, that while the control system is operated by power supplied from our own hydro, the deep well pumps are operated by power purchased from our neighboring municipality of North York. In case of power failure on the North York system at this point, we can, by means of switches at the boundary, throw in a supply of power from the Weston system during power interruptions in the locality of the deep wells served by North York. This gives us two sources of power supply available at the wells.

We are able to meet the additional carrying charges on the deep wells debenture, and additional power costs of purchasing power outside of our own municipality, out of the saving in the operation of the deep wells over the old system. The automatic control system, which has reduced operating costs considerably, has featured largely in this saving.

THAWING OUT FROZEN WATER PIPES

Around 1916 during a very severe winter, many of our customers were without water as a result of the frost penetrating to the depth of their water pipes, and freezing the supply of water.

The waterworks utility was consulted immediately, asking why we had cut off the water, when their water rates were not in arrears.

Thawing out water pipes by means of electricity at that time was

little known, but experiments we understand had been carried out successfully in Guelph, and possibly Mr. Haig can bear me out in this statement.

We experimented with an equipment of our own design, and found that it worked very satisfactorily. We thawed out possibly one to two hundred services during the winters of 1916 and 1917. It was not again required until this winter, when we have thawed out about one hundred services.

We do not claim to be the sole originator of the thawing equipment in 1916, but such an outfit used for this purpose was quite unknown around these parts up to the time we carried out our first experiment, which proved quite successful. At that time, and since, we have supplied many sketches of our hook-up, and described it many times over the telephone in answer to inquiries of the hook-up required for a thawing outfit.

We place the equipment in our truck, which consists of a 25 KVA lighting transformer over which has been erected a cross-arm, and on which we mount a primary cutout and ammeter. Primary connection is the usual 4400 to ground through the transformer, and the two wire secondary 110 volt leads, one end of which is connected to the customers water pipe just inside the cellar. The other secondary wire is cut through a water rheostat, which consists of an ordinary 40 gallon barrel loaded on the truck, each end of the wire being wound into a spring coil, one fastened to the bottom of the barrel, and the other supported near the top of the barrel. The coils must not touch, but the top coil is raised or lowered according to the amperage required for the particular job in hand. The barrel is then filled about two-thirds full of water to which has been added about 15 pounds of salt to make a brine solution. The coils must be submerged in the brine.

When we arrive at a house in which the pipes are frozen, we connect up the primary wire to the 4400 volt line, and the other lead to the ground wire. The secondaries are then placed, one inside the customer's house on the pipe line immediately where it enters the house, and the other is cut through the water rheostat, and then to the curb cock shut off at the street line. If we are unable to secure results by this connection, we know that the frozen part must be out on the street, so the wire on the curb cock, or service box, is switched to some other point, possibly a neighbor's service box connection, or nearby hydrant, and results are obtained within a few minutes.

If the pipes were found frozen on the customer's portion of the service, we make a nominal charge of $2.00 to cover cost of the work, but if the frozen part was found to be under the street, the waterworks assume the charges.

During this winter we have had many services to thaw out, and we have journeyed out into the country to assist the farmer and the gardener, in getting water services back into operation, after being frozen up for several days.

We have found that it takes only a few minutes to thaw out the most stubborn cases, and the following has been recorded:

PIPE SIZE	AMPERES REQUIRED	APPROXIMATE LENGTH OF PIPE	APPROXIMATE TIME REQUIRED TO THAW
inches		*feet*	*minutes*
¾	250	300	3 to 10
1	300	250	5 to 15
1½	350	200	10 to 20
2	400	150	15 to 30

While the voltage used is low, we use rubber covered No. 4 cable in making all connections.

If we find there is no primary line near the customer's house where the pipes are frozen, and there is a series return street lighting circuit at that point, we temporarily disconnect the street lighting cir cuit, and connect the 4400 primary at the distant point, and carry it to the thawing equipment until the pipes have been thawed, and then renew the series street lighting service again. We have also disconnected house service wires, and used one side for a primary connection, instead of running a long line of cable carrying the primary 4400 over ground to the frozen pipe.

PROBLEMS OF FILTRATION PLANT OPERATION

By G. H. Baker

(*Engineer, Township of North York, Can.*)

Thanks to the vast amount of research and experimental work that has been carried out along the lines of water filtration plants and made available in text books, engineering works and technical journals, it is now possible to select a proven design suitable to local conditions and requirements which can be relied upon in advance to give satis-

factory results. However, it must not be assumed that such a plant of modern design can be put into operation and be expected to give satisfactory results indefinitely and permit the waterworks engineer, operator, and consuming public to "live happily ever after." Irrespective of the design chosen or the care followed in construction, it is inevitable that, from time to time, changed conditions, whether temporary or permanent, present problems that must be solved, if the output of the plant is to be kept at the standard demanded by a critical public.

In this paper two problems encountered in the operation of the filtration plant of North York Township, and the steps taken to overcome them, are briefly outlined, with the hope that they may prove interesting and possibly helpful in solving similar problems.

The North York Township Filtration Plant, located where the east branch of the Don River crosses the Lansing sideroad 2½ miles east of Yonge Street, supplies an urban population of about 8,000, residing contiguous to the Yonge Street highway immediately north of the City of Toronto. This plant is equipped with 3 rapid gravity filters each of 250 gallons per minute capacity, together with the usual alum mixing chamber and coagulation basin of two hours retention period. Chlorination of the filtered water is taken care of at the service pumps.

The raw water supply is drawn from the east branch of the river Don from a reservoir created by a dam constructed across the stream. Those of you who have seen the river Don as it wends its majestic way through the City of Toronto, will immediately realize that one of the problems is excessive turbidity, while the delectable aroma that arises from its surface might suggest the other. The river Don does not improve through its association with metropolitan Toronto. It becomes bigger, but not better. At the point from which our supply is drawn, it compares favourably with any other rural stream.

The plant during the first few years of operation produced a quality of water, for the major portion of the year, that left little to be desired. But for a short period each year, varying from two weeks to one month according to the season, a degree of turbidity was encountered with which the filters were unable to cope. The alum dosage at the mixing chamber was increased to the practical limit, but failed to reduce the turbidity of the influent water to less than 50 p.p.m. The output remained cloudy resulting in numerous complaints from the consumers.

This condition might have been remedied by the construction of a larger coagulation basin, to allow a greater length of time for settling, but, as this would require considerable capital expenditure to take care of a condition of only short duration, some less expensive solution was sought. In collaboration with the engineers of the Provincial Board of Health experiments were carried out at the plant, as a result of which the expedient of adding an alum solution directly to the top of the filters was tried. The addition of 5 grains per gallon in this way caused the filter to produce the desired results almost immediately, although several times this quantity added before coagulation produced no improvement. A $\frac{3}{4}$-inch pipe line and the necessary metering valves, to feed the alum solution to the filters, was the only change necessary. This treatment produces the desired results and enables the filters to deliver successfully a clear effluent with a coagulated water containing, at times, a turbidity in excess of 50 p.p.m. This procedure enables us to combat the unusually high turbidity of the spring freshet season, but is not used for the balance of the year.

The second problem encountered during the early years of the plant's operation also results from the conditions created during the Spring break-up in the river. The melting snow and spring rains wash down a large quantity of grass, weeds and various vegetable matter which permeates the water with an unpallatable marshy taste and smell. The objectionable smell was particularly noticeable on boiling the water, the rise in temperature seeming to drive off the gases. Naturally this condition was not relished by the consumer and numerous complaints resulted. Experiments in aeration were conducted, using a compressor loaned by the Provincial Board of Health, which gave such promising results that a permanent installation was made. This consisted of a Nash-Hytor compressor, driven by a 3 H.P. motor, and connected to sewage type diffusion plates, located at the bottom of the mixing chamber. A liberal quantity of finely diffused air is thus caused to percolate through the water, and rising to the surface carries off the objectionable vegetable matter, which forms a large cone of soap-like bubbles on the surface of the mixing chamber and part of the coagulation basin. This eventually breaks down leaving a brown earth like scum floating on the surface, necessitating daily removal. This arrangement removed entirely the objectionable taste and odor at a comparatively small capital outlay. The operating costs are merely the current required to operate a 3 H.P. motor.

In conclusion, may I add a word of appreciation for the help provided by the Ontario Board of Health in solving these and similar problems with which we have been confronted from time to time. The active coöperation of the Experimental Section, under Mr. Delaporte and his able and experienced staff, has been of the greatest assistance.

THE NEW WATER PURIFICATION PLANT FOR SPRINGFIELD, ILLINOIS

By Charles H. Spaulding

(Superintendent of Water Purification, Springfield, Ill.)

AND

C. S. Timanus

(With Burns & McDonnell Engineering Company, Kansas City, Mo.)

The new water purification plant at Springfield, Illinois, is a part of an unusual utility improvement program which has been consistently carried forward through the depression period. Under this program the City of Springfield has completed a new impounded water supply at a cost of over $2,500,000, and is now constructing at a cost of $1,000,000 the first unit of a municipal power plant and pumping station which will ultimately cost over $4,000,000. The water purification plant, the third major item of this program, will go under construction as soon as contracts are awarded on the plans and specifications now prepared.

The new plant, having an ultimate capacity of 36 m.g.d., will be constructed near the dam that forms the new lake. This lake is over six square miles in area, and impounds 21 billion gallons of water. It is believed that when the lake is filled the water will show a hardness of 150 to 200 p.p.m., most of which will be carbonate hardness. The turbidity of the water will, of course, be low at all times, and the sanitary quality should be excellent on account of the character of the water-shed and the sanitary control of the lake area which has been established.

The design of the new plant is based upon experience gained in the operation of the existing plant, together with the results of research in special problems of filtration and basin design at the existing plant. While the plant in outward appearance and in many features of its design follows conventional practice, there are a number of definite departures from the conventional that have resulted in a plant costing only $22,000 per million gallons capacity, based on six filter units. (Two of these will be omitted at present.) When it is remembered

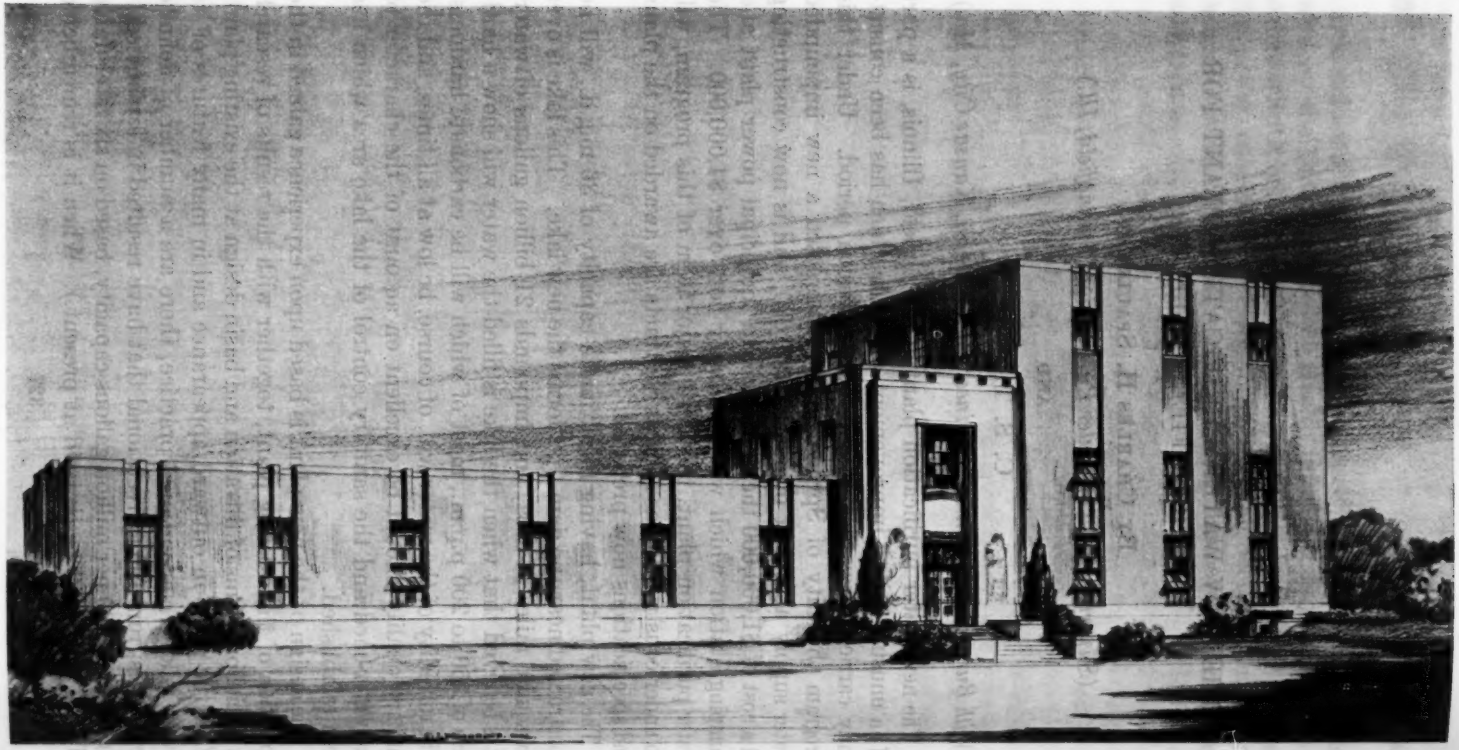


FIG. 1. WATER PURIFICATION PLANT, CITY OF SPRINGFIELD, ILLINOIS

that many of the water softening plants now operating have cost from $30,000 to $40,000 per million gallons of capacity, the saving indicated becomes significant as presaging the more general adoption of the softening process in water treatment.

Lime softening and recarbonation to a residual hardness of 80 to 100 p.p.m. is the principal treatment process to be employed. Auxiliary alum application will be provided and pre-chlorination in conjunction with ammonium sulphate will be used. Activated carbon will also be available for odor and taste control.

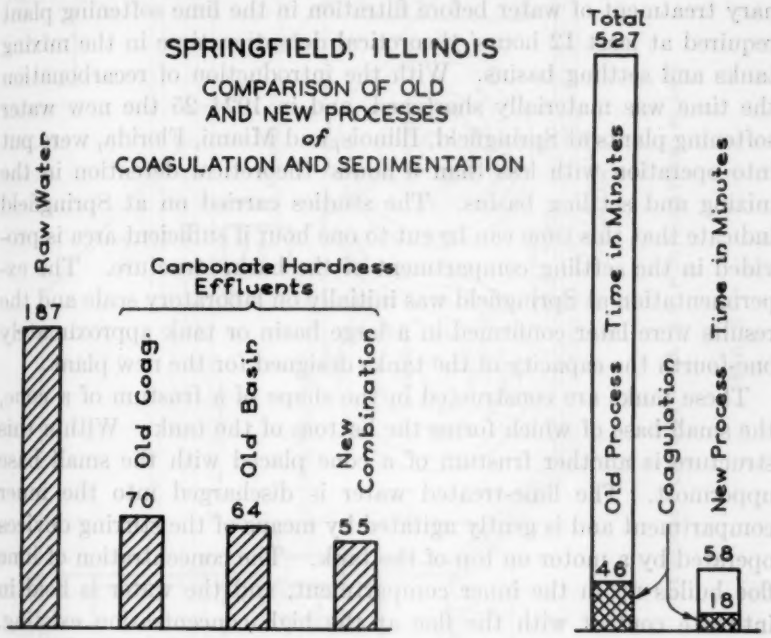


FIG. 2

Normally, the raw water will be taken directly from the lake; but, in order to speed up the chemical reactions in cold weather, provision has been made to take the entire raw water supply from the warm water of condenser circulating system of the nearby power plant.

Water is delivered through a 30-inch main to the rising well adjacent to the head house of the new plant. From the rising well to the basins the flow is through an open flume constructed of concrete. Lime is applied to the water in this flume just after it leaves the rising well. The basins may be operated in either of two ways. The water

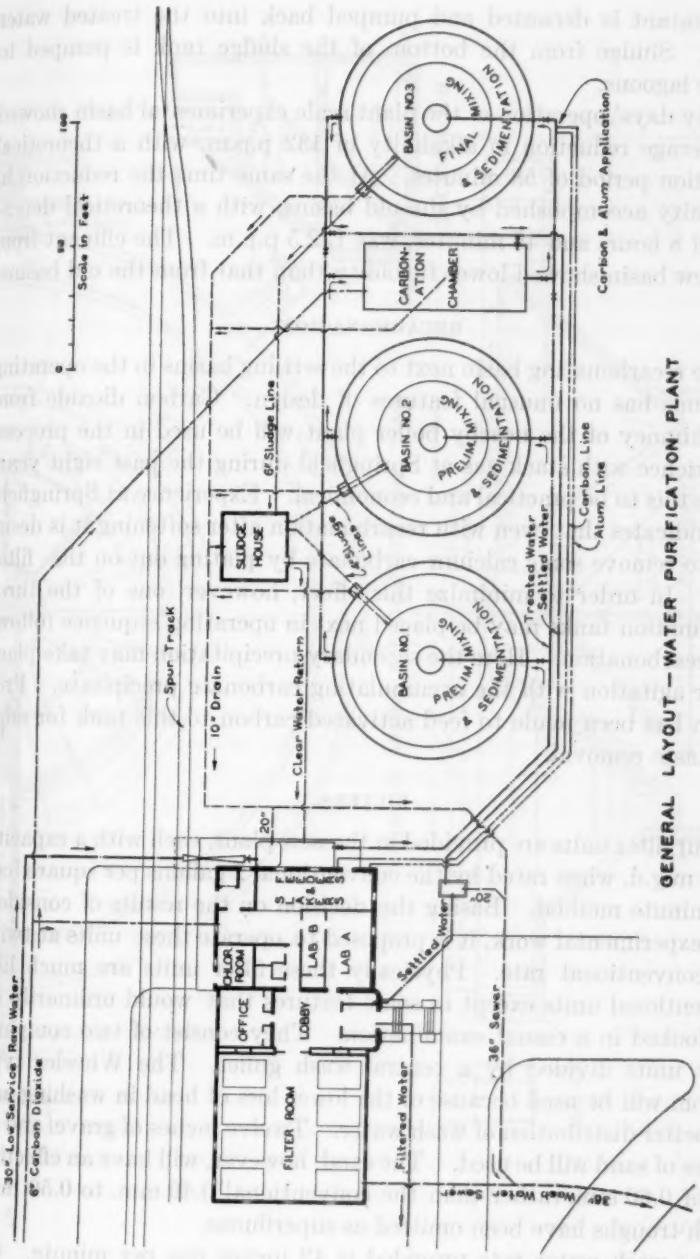
FIG. 1. WATER PURIFICATION PLANT, CITY OF SPRINGFIELD, ILLINOIS

may flow in parallel through three principal coagulating and settling tanks, following which it is recarbonated and sent to the filters. In the other method the water passes through two of the basins, after which it is recarbonated and then passed through the third for stabilization before going to the filters. The choice of methods will depend on operating conditions.

PRETREATMENT

Fifteen years ago it was quite generally thought that the preliminary treatment of water before filtration in the lime softening plant required at least 12 hours' theoretical detention time in the mixing tanks and settling basins. With the introduction of recarbonation the time was materially shortened, and in 1924–25 the new water softening plants at Springfield, Illinois, and Miami, Florida, were put into operation with less than 6 hours' theoretical detention in the mixing and settling basins. The studies carried on at Springfield indicate that this time can be cut to one hour if sufficient area is provided in the settling compartment of the basin structure. The experimentation at Springfield was initially on laboratory scale and the results were later confirmed in a large basin or tank approximately one-fourth the capacity of the tanks designed for the new plant.

These tanks are constructed in the shape of a frustum of a cone, the small base of which forms the bottom of the tank. Within this structure is another frustum of a cone placed with the small base uppermost. The lime-treated water is discharged into the inner compartment and is gently agitated by means of the stirring devices operated by a motor on top of the tank. The concentration of lime floc builds up in the inner compartment, and the water is held in intimate contact with the floc at the high concentration existing. At the bottom of the tank around the outside edge is an opening from the interior compartment to the settling compartment which lies between the walls of the inner and outer cones. As the water passes to the settling compartment the floc continues in contact with the water—never, however, under proper operation, reaching the surface of the settling compartment. The upward velocity of the water in the settling compartment, which is controlled by the surface area of the compartment, is the principal design feature affecting the capacity of the tank. Water carrying a heavy concentration of floc is bled from the interior compartment of the main tank and discharged to a separate sludge concentrating tank, from which the



GENERAL LAYOUT — WATER PURIFICATION PLANT

FIG. 3

supernatant is decanted and pumped back into the treated water flume. Sludge from the bottom of the sludge tank is pumped to sludge lagoons.

Sixty days' operation of the plant scale experimental basin showed an average reduction in alkalinity of 132 p.p.m. with a theoretical detention period of 58 minutes. At the same time the reduction in alkalinity accomplished by the old basins, with a theoretical detention of 8 hours and 46 minutes, was 122.5 p.p.m. The effluent from the new basin showed lower turbidity than that from the old basins.

RECARBONATION

The recarbonating basin next to the settling basins in the operating sequence has no unusual features of design. Carbon dioxide from the chimney of the nearby boiler plant will be used in the process. Experience with stack gas at Springfield during the past eight years shows this to be practical and economical. Experience at Springfield also indicates that even with recarbonation after softening it is desirable to remove some calcium carbonate by plating out on the filter sand. In order to minimize this effect, however, one of the three combination tanks may be placed next in operating sequence following recarbonation. Here the secondary precipitation may take place under agitation with the accumulating carbonate precipitate. Provision has been made to feed activated carbon to this tank for odor and taste removal.

FILTERS

Four filter units are provided in the new plant, each with a capacity of 1½ m.g.d. when rated by the conventional 2 gallons per square foot per minute method. Basing the decision on the results of considerable experimental work, it is proposed to operate these units at twice the conventional rate. Physically these filter units are much like conventional units except in some features that would ordinarily be overlooked in a casual examination. They consist of two compartment units divided by a central wash gullet. The Wheeler type bottom will be used because of the lower loss of head in washing and the better distribution of wash water. Twelve inches of gravel and 24 inches of sand will be used. The sand, however, will have an effective size of 0.60 mm. rather than the conventional 0.40 mm. to 0.50 mm. Wash troughs have been omitted as superfluous.

The wash water rate provided is 42 inches rise per minute. On

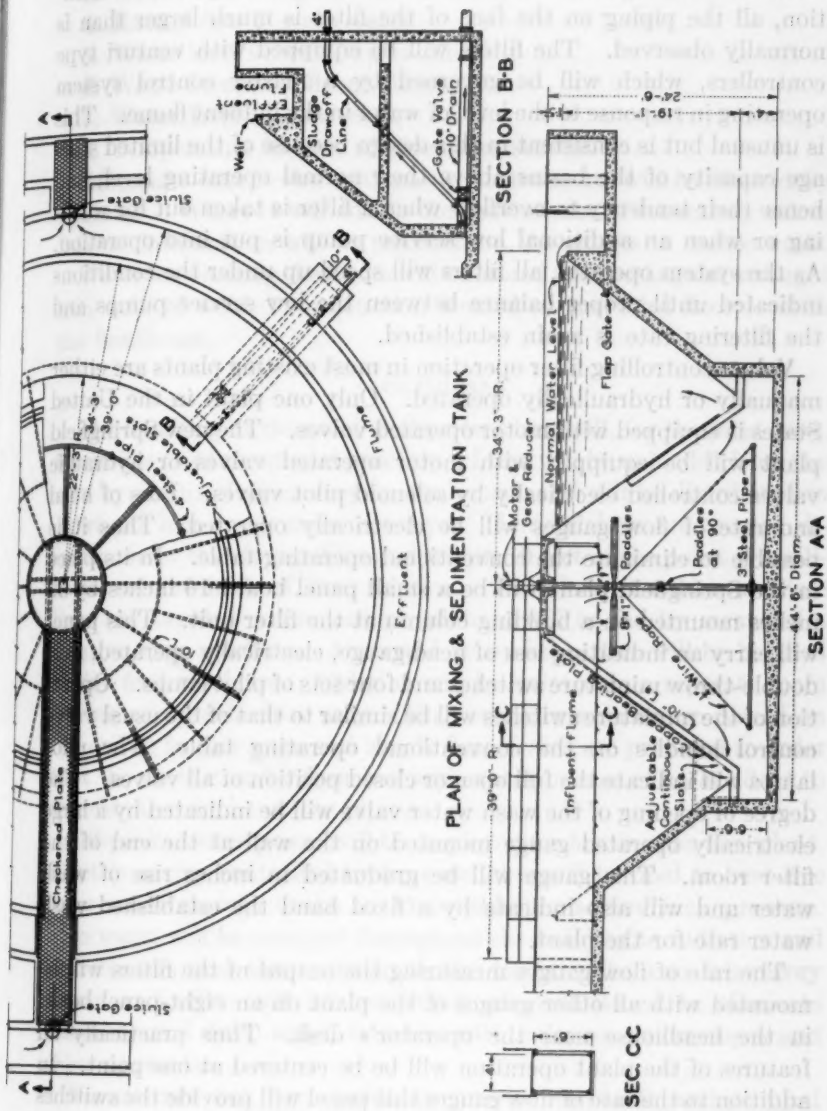

PLAN OF MIXING & SEDIMENTATION TANK
SECTION B-B
SECTION A-A
SEC. C-C
Sluice Gate
Checkered Plate
Effluent Flume
Sludge Drawoff Line
Gate Valve 10" Drain
Weir
Motor & Gear Reducer
Normal Water Level
Flap Gate
Paddles
Paddles at 90°
3" Steel Pipe
Influent Flume
Adjustable Continuous Slots
Effluent
Adjustable Slots
4" Steel Pipe
39'-0" R
34'-3" R
22'-3" R
44'-6" Diam

FIG. 4

account of this high wash rate and on account of the high rate of filtration, all the piping on the face of the filter is much larger than is normally observed. The filters will be equipped with venturi type controllers, which will be governed by a master control system operating in response to the level of water in the influent flume. This is unusual but is consistent in this design because of the limited storage capacity of the basins above their normal operating level, and hence their tendency to overflow when a filter is taken out for washing or when an additional low service pump is put into operation. As the system operates, all filters will speed up under the conditions indicated until proper balance between the low service pumps and the filtering rate is again established.

Valves controlling filter operation in most existing plants are either manually or hydraulically operated. Only one plant in the United States is equipped with motor operated valves. The new Springfield plant will be equipped with motor operated valves or hydraulic valves controlled electrically by solenoid pilot valves. Loss of head and rate of flow gauges will be electrically operated. Thus it is possible to eliminate the conventional operating table. In its place in the Springfield plant will be a small panel board 16 inches by 32 inches mounted on a building column at the filter unit. This panel will carry an indicating loss of head gauge, electrically operated, four double-throw miniature switches and four sets of pilot lamps. Operation of the miniature switches will be similar to that of the usual valve control handles on the conventional operating table. The pilot lamps will indicate the full open or closed position of all valves. The degree of opening of the wash water valve will be indicated by a large electrically operated gauge mounted on the wall at the end of the filter room. This gauge will be graduated in inches rise of wash water and will also indicate by a fixed hand the established wash water rate for the plant.

The rate of flow gauges measuring the output of the filters will be mounted with all other gauges of the plant on an eight-panel board in the headhouse near the operator's desk. Thus practically all features of the plant operation will be be centered at one point. In addition to the rate of flow gauges this panel will provide the switches for controlling the raw water pumps and the CO_2 compressor and gauges for recording the following functions of plant operation:

1. Rate of flow of raw water.
2. Temperature of raw water.

3. Outside air temperature.
4. Rate of flow of wash water.
5. Water level in wash water tank.
6. Water level in influent flume.
7. Water level in clear well.
8. Temperature in each of three lime slakers.

All gauges except the temperature instruments will be electrically operated. Where it will add to the convenience of laboratory calculations, information will be recorded on the gauges in metric units.

Water for washing the filters will be stored in a rectangular wrought iron tank of welded construction located at the third floor level in the headhouse.

CHEMICALS

The handling of chemical in the new plant will, for the most part, be similar to conventional practice. Lime will be unloaded from the cars by means of air-conveying equipment and will be distributed to overhead bins by a screw conveyor. Lime slakers are located directly under the storage bins and within 10 feet of the point of application of the milk of lime solution. Thus long, troublesome lime lines are avoided. Ammonium sulphate will be fed by means of a solution type machine. Alum and activated carbon will be handled in dry feed machines. Chlorine will be isolated in a separate room having an outside door only. High capacity nozzles are placed on the ceiling in this room and ample floor drains are provided in order that the room may be drenched with water in case of an accident to the chlorine drums or the piping.

Off-peak electric power will be employed for heating the new plant. Electric energy controlled by time switches will be used to heat five large water storage tanks to 15 pounds per square inch pressure. This water will be pumped throughout the building to radiators and unit heaters and thence back to the tanks. The two laboratory rooms and office will be completely air-conditioned to eliminate humidity and dust, which interfere with balances, microscopes and other apparatus.

No attempt has been made to provide elaborate architectural treatment to the building. The exterior harmonizes with the nearby power plant building, which is of conservative, modern design. The interior of the plant is distinguished by quarry tile floors, tile walls and indirect artificial lighting.

The work at Springfield is under the general direction of Mr. Willis J. Spaulding, Commissioner of Public Property. Mr. Charles H. Spaulding, Superintendent of Water Purification, has had general supervision of the design and direct charge of research work. The Burns & McDonnell Engineering Company prepared the plans and specifications under the direction of C. S. Timanus.

(*Presented before the Missouri Valley Section meeting, November 8, 1934.*)

THE NEW IRON AND MANGANESE REMOVAL PLANT FOR LINCOLN, NEBRASKA

By D. L. Erickson

(*City Engineer, Lincoln, Neb.*)

The discovery of manganese in the ground water of the Platte River Valley near Ashland in 1933 was the first known occurrence of manganese in waters in Nebraska in sufficient amount to become seriously objectionable. The amount of manganese that may be tolerated is very small, most authorities considering anything over 0.1 p.p.m. as being objectionable.

HISTORY OF ASHLAND SUPPLY

Prior to 1932, Lincoln's water supply was obtained from thirty-two wells, divided into four groups—all located within the city limits, each having a capacity of approximately one-half million gallons per day. The records of ground water levels showed that in the twenty-year period from 1910 to 1930, the ground water level was receding at the rate of 2 feet per year and in the year 1930, the recession amounted to 5 feet. In the same year, the four wells in the 31st and X street group became so salty that they all had to be discontinued.

In the spring of 1931, the voters approved a bond issue in the sum of $2,300,000 for the purpose of developing an additional supply of water from the Platte River Valley near Ashland.

Five wells were then constructed in the Platte River Valley approximately three miles northeast of the town of Ashland. These wells are 2000 feet apart in a direct north and south line, the distance from the Platte River varying from approximately one-fourth mile at the extreme north well to three-fourths of a mile at the extreme south well. The depth of the wells varies from 47 to 86 feet, all going down to the white limestone valley floor.

The soil formation in all five wells is practically the same, consisting of a mixture of sand and gravel below a top soil, 12 to 18 inches deep. The ground water table is quite high, being located from 4 to 6 feet below the surface of the ground.

Each well is equipped with a deep well pump having a capacity of two and one-half million gallons per day. These pump into a 36-inch pipe line, which discharges into a three million gallon reservoir, located approximately two and one-half miles from the nearest well.

At this reservoir a pumping station is located with two centrifugal pump units—one 6 and one 9 million gallon per day—which pump into a 36-inch cast iron pipe line, 25 miles long, which delivers the water to Lincoln.

At the Lincoln end of the pipe line, the water discharges into a group of covered concrete suction reservoirs, totaling 34 million gallons in capacity, from which the water is then repumped into the water distribution system by means of four pumping stations located in different parts of the City.

The new Ashland water supply was completed in July, 1932, at a cost of approximately $1,800,000.00 and was put into service in August, 1932. This supply was then used continuously for a period of a year with entirely satisfactory results. In fact the Ashland water was favored for use by the consumers, being somewhat softer than the local Lincoln water.

In September, 1933, overnight, the tap water became turbid, having the appearance of having had black ink mixed with the water. The water did not have a bad odor or taste, but looked bad. An investigation disclosed a 6-inch layer of sludge or deposit on the bottom of all of the Lincoln reservoirs, and the water in the Ashland Reservoir was found to contain rust colored threadlike particles suspended in the water. A gelatinous coating was found on the inside of the twenty-five mile, 36-inch pipe line, which was brownish red in color at the Ashland end of the pipe line and black at the Lincoln end. Chemical analyses of this gelatinous coating disclosed that it contained high percentages of manganese.

The use of the Ashland supply was discontinued for a few days, while all the reservoirs were cleaned, and the entire twenty-five miles of 36-inch pipe line was thoroughly flushed through the blowoffs provided at all low points in the pipe line. After a thorough cleaning of all structures in this manner, the Ashland supply was again put into service; and since that time it has been possible to use this supply by systematic flushing of the 36-inch pipe line every three weeks.

ENGINEERING LITERATURE ON MANGANESE

A study of the existing engineering literature on the subject of manganese in water and the methods of its removal reveal wide differences

in opinion amongst the various writers. There is a general agreement as to the chemical explanation for the presence of manganese in ground waters, in that such waters usually contain CO_2 and no dissolved oxygen, and that under such conditions manganous salts will go into solution. When the ground water is pumped from the soil, the CO_2 tends to liberate itself and free oxygen is absorbed, the manganous salts becoming manganic salts which are less soluble and therefore tend to precipitate out.

Some writers advance the hypothesis that the removal of manganese from water may be accomplished by bacteriological action and

TABLE 1

Partial mineral analyses of samples of water from the wells of the Lincoln, Nebraska, water supply, and from the Platte River

	WELL NUMBER					PLATTE RIVER	LINOMA BEACH	BALLOU GRAVEL PIT
	1	2	3	4	5			
Manganese (Mn)	1.25	0.95	0.30	0.25	0.36	0.12	0.38	0.28
Iron (Fe)	0.30	0.30	0.55	0.60	0.45	0.10		
Alkalinity	182.0	148.0	132.0	138.0	152.0	146.0		
Free CO_2	35.0	21.0	13.0	17.0	25.0	2.0		
pH	7.2	7.2	7.3	7.2	7.1	8.0		
Chloride (Cl)	9.0	9.0	4.5	6.0	7.5	10.0		
Calcium (Ca)	64.5	50.5	33.9	43.7	53.9	43.1		
Magnesium	12.1	9.0	6.4	8.0	10.3	10.3		
Sulfate (SO_4)	68.1	65.3	35.0	44.5	53.9	74.7		
Hardness	210.9	163.2	111.0	142.0	177.1	150.0		

The samples were received October 11, and tested between October 12 and 16, 1933. Results, except pH, in parts per million.

others by chemical action. Recently the hypothesis of catalytic action has been advanced. A majority of the writers agree, however, that the behavior of manganese in water is similar to that of iron, and that the removal of the two is also similar, but that it is more difficult to remove manganese, in that it requires more time and more preliminary treatment. They also agree that manganese is more readily removed in the case of harder waters that are also low in organic matter. All agree that both iron and manganese are readily removed by the ordinary water softening processes, and that manganese may be removed by the addition of lime followed by filtration.

In October, 1933, the City engaged Mr. John R. Baylis, Physical

Chemist of the City of Chicago to help solve this problem confronting the City. The results of the chemical analyses made by Mr. Baylis are shown in tables 1 and 2.

It will be noted that in the five Ashland wells, the manganese content varies from 0.25 to 1.25 and that the iron content varies from 0.3

TABLE 2

Manganese and iron tests on samples of water from cities and villages along the Platte River, Nebraska

	IRON, Fe		MANGANESE, Mn	
	First test	Second test	First test	Second test
Ashland, Platte River	7.50	0.14	0.12	0.00 tr*
Ashland, Well No. 1	0.38	0.35	1.25	1.25
Ashland, Well No. 2	0.60	0.50	0.85	0.83
Ashland, Well No. 3	0.65	0.65	0.30	0.30
Ashland, Well No. 4	0.58	0.60	0.30	0.30
Ashland, Well No. 5	0.42	0.40	0.34	0.33
Memphis (sample broken)				
Wann, C. B. & Q., Depot well	0.30		0.85	0.80
Yutan, town water supply	0.68		0.06	0.06
Mead, town water supply	0.22		0.02	0.025
Wahoo, town water supply	0.11		0.02	0.01
Valley, town water supply	0.14		0.04	0.03
Waterloo (sample broken)				
Fremont, city supply	0.08		0.02	0.02
Fremont, Platte River	5.00	0.03*	0.09	0.00 tr*
Schuyler, city supply	0.38		0.01	0.01
Columbus, city supply	0.70		0.60	0.58
Columbus, Loup River	8.00	0.12*	0.10	0.00 tr*
Grand Island, city supply	0.08		0.00 tr	0.00 tr
Grand Island, Platte R.	2.10	0.05*	0.05	0.00 tr*
Seward, city supply	0.14		0.00 tr	0.00 tr

* Sample filtered before being tested.

Samples collected October 31 and November 1, 1933. Results in parts per million.

to 0.6 p.p.m. The wells containing the least amount of manganese are those closest to the river and as the distance from the river increases the manganese content also increased.

The samples included in table 2 were taken from various towns in the Platte River Valley from Ashland north and west as far as Grand

Island, to determine the extent to which manganese might be present in the Platte River Valley.

It will be noted that 0.8 p.p.m. manganese was found at Wann, Nebraska, and 0.6 in the city's supply at Columbus, but that the city's supply at Grand Island only disclosed a trace of manganese.

Table 2 also shows the presence of 0.1 p.p.m. of manganese in the Loup river at Columbus and 0.05 in the Platte River at Grand Island, indicating that there must be substantial manganese deposits in the Loup River Valley north of Columbus and even some deposits in the Platte River Valley west of Grand Island.

Mr. Baylis points out the following probable cause of the manganese at Ashland.

> Where the ground water contains manganese there usually will be some depositing of manganese where the oxygen of the air comes in contact with the ground water. The penetration of oxygen into the ground varies widely. In many soils, it probably extends only a few inches below the surface whereas in others it may extend a number of feet below the surface. Where the ground water level is deep and the movement of water through the ground near the surface is rain water penetrating downward through the soil, it is not likely that this condition will deposit much manganese in the soil near the ground water level; but where the ground water level is only a few feet below the surface it is probable during dry periods that some of the water gradually moves towards the ground surface by capillary attraction and evaporates into the air. The manganese in this water becomes oxidized and deposits at certain points in the soil. This may be near the ground surface at some points and several feet below the surface at other points. The deposit keeps accumulating so long as the condition exists. If the deposit is near the normal or low ground water level and there is an increase in the ground water level which covers some of the deposited manganese with water free from dissolved oxygen, the manganese will be dissolved and will increase the normal manganese content of the water. This is a probable cause of the high manganese in the water from the wells of the Lincoln supply on the Platte River.

Mr. Baylis pointed out that the only way to determine the most economical method of manganese removal for our particular water was to construct an experimental manganese removal plant at Ashland and to run a series of experiments, from which the proper data for the final plant design could be obtained.

EXPERIMENTAL PLANT

Accordingly a parallel series of several miniature manganese removal systems were set up and put in operation at Ashland. These provided for aeration, sedimentation, contact filters and rapid sand filters.

A complete chemical laboratory was also set up with a graduate chemist in charge, who kept daily records of the iron, manganese, CO_2, O_2, and pH at each step in each system so that a definite determination could be made of the iron and manganese removal ability of each system and the relative value of each step, materials, etc.

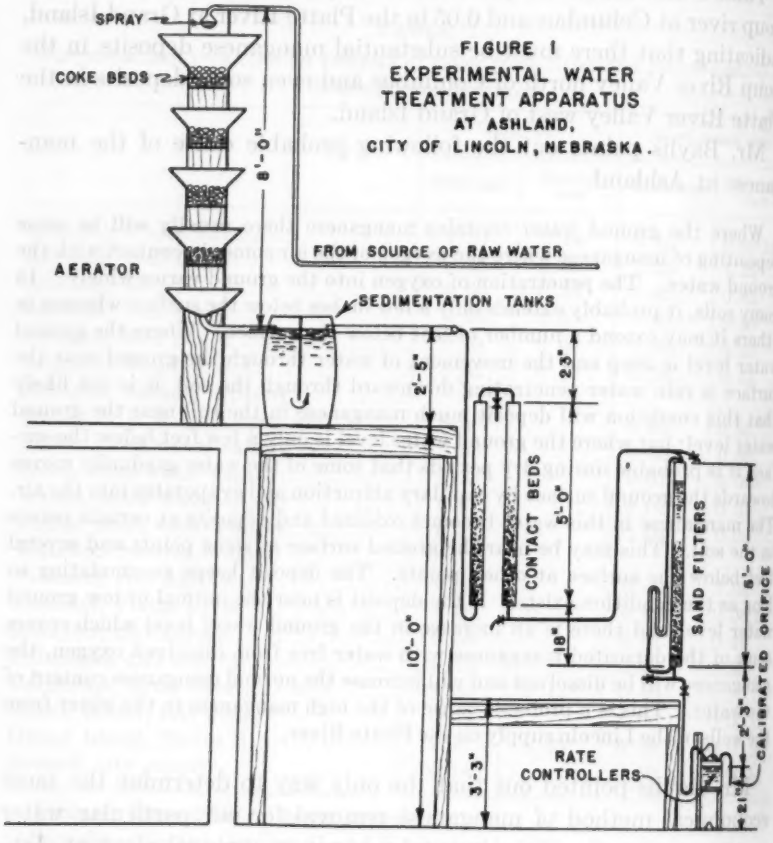


FIG. 1

Aeration

The aerator in the experimental plant provided for an area of one square foot and consisted of four trays filled with coke placed directly one above the other. The aerating process was conducted at varying rates and an accurate check kept on the CO_2 removal and the free

oxygen absorbed. The excess water that was not needed for the succeeding steps in the plant was bypassed and wasted.

Sedimentation

In the original setup, three wooden barrels placed in series were used as a sedimentation basin with provision to take off of each barrel to determine the effect of varying periods of sedimentation.

Contact filters and rapid sand filters

Both the contact filters and the rapid sand filters were made of pyrex glass tubes approximately two inches in diameter and approxi-

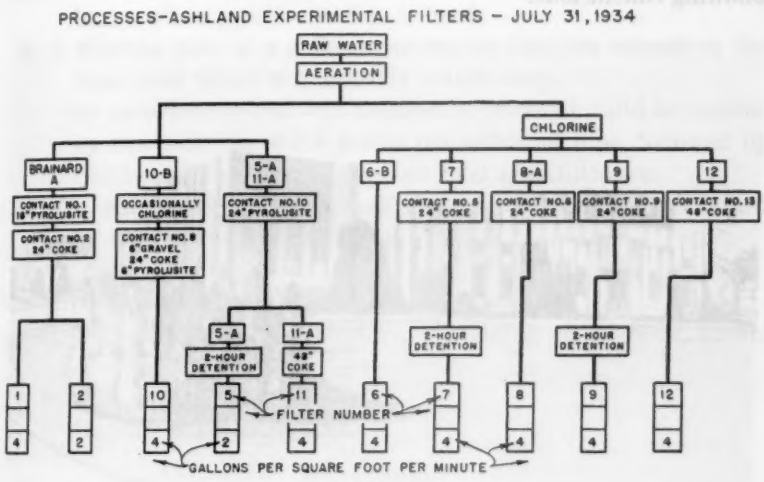


FIG. 2

mately five feet long, which gave a small filter true to vertical scale and approximately 0.02 square foot in horizontal area. Experiments were conducted on contact filters filled with the following media:

1. Coke.
2. Pyrolusite (manganese ore).
3. Gravel.
4. Combination of coke and pyrolusite.

Some of the final sand filters were filled with Ottawa sand and others with Platte River sand. Experiments were made on the basis of filtering at 2 and at 4 gallons per square foot per minute.

Chlorination

After the experimental filter plant had been set up and started in operation, provision was made for chlorination, on a portion of the systems being tested in order to determine the effect of pre-chlorination.

The experimental filter was put into operation in January, 1934, and is still in operation. At the present time 8 different systems of iron and manganese removal are being conducted as shown on figure 2.

The writer will not attempt in this brief paper to describe in detail the various phenomena disclosed during the operation of this experimental test filter. In general, the results so far obtained justify the following conclusions.

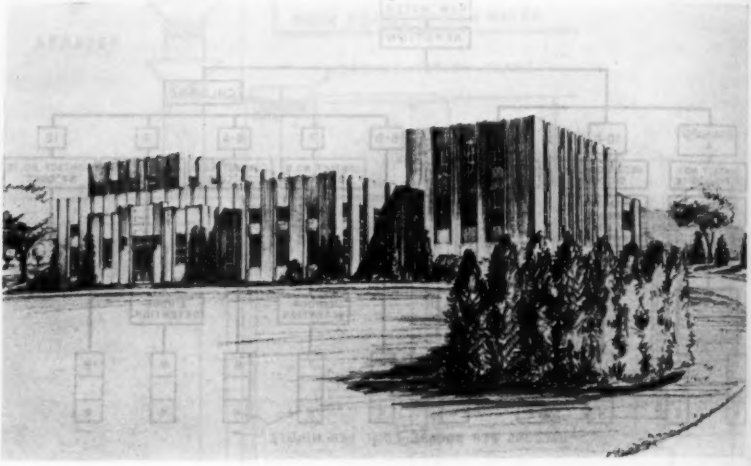


FIG. 3. ARCHITECT'S SKETCH OF THE PUMPING STATION AND NEW IRON AND MANGANESE REMOVAL PLANT FOR LINCOLN, NEBRASKA

1. Rates of aeration as high as 40 gallons per square foot per minute secured very satisfactory CO_2 removal and as high as 90 percent saturation of oxygen absorption.
2. The contact filters containing pyrolusite gave very satisfactory manganese removal in the beginning, but after a period of thirty days the efficiency of the pyrolusite contact filters rapidly decreased to the point where at the end of 60 days they were not effective at all. The particles of pyrolusite apparently became coated with a brownish gelatinous material which seemed to interfere with the process. It was

found to be possible to clean the pyrolusite and restore the pyrolusite filter to its former efficiency by washing with 5 percent solution of either sulphuric acid or hydrochloric acid.

3. In seeking means of cleaning the pyrolusite filter, it was discovered that its efficiency could be restored by the application of 1.0 p.p.m. of chlorine, immediately after aeration. This was only effective for a few days. Later it developed that very satisfactory results could be secured by chlorinating ahead of the contact filters containing gravel or coke.
4. The use of coke in the contact filters gave about the same results as gravel.
5. There was no apparent benefit derived from the sedimentation basin, when prechlorination is used.
6. A filtering rate of 4 gallons per square foot per minute in the final sand filters was entirely satisfactory.
7. Very satisfactory iron and manganese removal could be secured by the addition of 2.5 grains per gallon of lime, followed by two hours of sedimentation and final sand filtration.
8. Very satisfactory iron and manganese removal could be obtained by the following steps.
   A. Aeration.
   B. Chlorination (from 0.5 to 1.0 p.p.m.).
   C. Upward flow contact filters, containing either coke, gravel or pyrolusite.
   D. Two-hour sedimentation.
   E. Rapid sand filtration.

FINAL PLANT

On January 24, 1934, the City retained Black and Veatch, Consulting Engineers, to assist in the design of the final plant, and this firm had their chemist visit the site of the experimental filter plant and gave very valuable assistance in interpreting the experimental results.

Basis of design for final plant

For forty years or more, the Water Department of the City of Lincoln has been operating under a water rate having a maximum of 15 cents per thousand gallons. With the fixed charges incurred by the new Ashland water system, this rate does not produce enough revenue to permit the consideration of the increased operating cost connected with water softening. It was not deemed advisable under the present general economic conditions to attempt to raise the water rates.

It was, therefore, decided that the present operation of the plant should be limited to the removal of iron and manganese, but that the plant should be capable of being converted into a complete water softening plant by the addition of the necessary chemical feeding equipment. Inasmuch as the present Ashland water project is designed for a capacity of 12 million gallons per day with provisions for increasing to 18 million gallons per day, it was decided that the iron and manganese removal plant should be designed for these same capacities.

The final plant was to comprise the following processes:

1. Aeration.
2. Chlorination.
3. Upward flow contact filtration.
4. Two-hour sedimentation.
5. Rapid sand filtration.

The experimental filter plant indicated that better results might be obtained without the two-hour sedimentation, but it was decided to build the sedimentation basin for future water softening processes, and as an additional safeguard for the present operation, with the plant so arranged that the sedimentation basin could be by-passed if desired.

Aerator

The aerator design is similar to that used at Memphis, Tennessee, consisting of three units of four trays each, with a 24-inch riser pipe supply in the center of each unit. The bottom of the trays is made of 2-inch slate, drilled with 116-inch holes spaced 6 inches center to center. Four inches of coke is to be placed in each tray.

The aerator is designed to operate at the rate of 28 gallons per square foot per minute at 12 million gallons per day, or 42 gallons per square foot per minute at 18 million gallons per day.

Contact filters

The contact filters are to be of the upward flow type, operating at the rate of 8 gallons per square foot per minute. There are to be two units. With the exception of the direction of flow and the filter media, the contact filters are of the same general construction as the final sand filters, so that whenever it is desired to go to complete water softening, the two contact filters can be converted into standard final sand filters by lowering the wash water troughs and making some minor piping changes to reverse the direction of flow. Provision is made for backwashing as in the standard sand filters.

The filter media in the contact filters is to be either pyrolusite (manganese ore), coke or gravel. The decision on this point is being deferred, pending more definite results from the experimental filter plant which is to be kept in operation during the construction of the plant.

Sedimentation

The sedimentation basin will have a capacity of one million gallons. It will be a rectangular, covered reinforced concrete basin, divided into two parts by a central wall. The water will enter through a baffle wall and pass slowly through the length of one-half of the basin, and back to the plant, passing over a weir at the outlet end of the basin.

Final filters

The final filters are of the rapid sand filtration type, there being four units. Each unit has a capacity of 3 million gallons per day, operating at a rate of 4 gallons per square foot per minute. The underdrain system of these filters consists of a series of 4-inch cast iron pipe laterals connected with a central concrete box. The cast iron laterals have a series of $\frac{3}{8}$-inch holes drilled 6 inches on centers. The filter media consist of 18 inches of graded gravel, on top of which is placed 2 feet of carefully graded sand.

The wash water troughs are made of concrete.

A clear well of 100,000 gallons capacity is provided underneath two of the final sand filters. Two electrically driven centrifugal pumping units are provided, one 7.5 and one 11 million gallons per day, which will pump the filtered water from the clear well to the existing 3 million gallon reservoir.

With the exception of the sedimentation basin, the entire new plant will be housed in a fireproof stone-faced structure, located immediately adjacent to the existing pumping station. Contracts for the entire plant have been awarded at a total cost of approximately $211,000.00, and the plant is now under construction with the expectation of being completed by May 15, 1935.

The plans and specifications for the iron and manganese removal plant were prepared by Black and Veatch, Consulting Engineers at Kansas City. The plant is being constructed under the direct supervision of the writer, all under the general supervision of Mr. Paul W. Doerr, Superintendent of the Water and Light Department.

(*Presented before the Missouri Valley Section meeting, November 8, 1934.*)

RECENT IMPROVEMENTS IN THE WHEELING, WEST VIRGINIA, WATER SYSTEM

By A. R. Todd

(Superintendent of Filtration, Water Works, Wheeling, W. Va.)

The present filtration plant and pumping station were put into operation in February, 1925. The capacity of the plant is 20 million gallons and the daily average is around 11 million gallons per day. Prior to 1925, that is, before the present plant was built and before metering, the daily pumpage was 20 million gallons. The prediction of the engineers that, by metering, the water consumption would be cut down to 11 or 12 million gallons was borne out.

The writer assumed charge of the filtration plant in November, 1933. At that time the management was receiving numerous complaints on red water, both on circulating mains and dead ends. This was particularly true in the Pike district. At times the taste of the water was anything to be desired. The water was being delivered to the city mains with a pH of 7.8 and a CO_2 content of 0 to 2 p.p.m.; and from 0 to a trace of iron. Analyses of samples taken from different portions of the city disclosed the fact that the water was very corrosive. The sample taken in lower Warwood, which is about one-half mile from the plant, showed 0.2 p.p.m. of iron; from the Island, 0.5 p.p.m.; in Benwood, 1.0 p.p.m.; and Elm Grove, 2.0 p.p.m. In other words, the longer the distance the water had to travel, the more iron it dissolved. Other tests showed that the CO_2 content increased to 4 to 6 parts; the pH dropped from 7.8 to 7.4; and the oxygen content decreased to almost zero. Prior to this time, the purification treatment had been alum and lime.

The sand in the filter beds was approximately 9 years old and an examination of the top 20 inches of sand showed it to be a thick, black, sticky mess. Upon drying the product, it was found to have a specific gravity of 1.3 whereas the specific gravity of new sand is 2.65. The sand grains were round and of a size equal to bird shot, and 50 grams of the material filled a 200 c.c. graduate up to the 150 c.c. mark. Cracks in the filter sand 6 inches wide and several feet long were numerous as also were mud balls. Owing to the condition of the sand, the loss of head and the rate of flow gauges were useless

Samples of the effluent had to be collected hourly from the different filters to determine when a filter should be washed. The filters would have run weeks before the loss of head would have indicated that a wash was necessary. It was thought that perhaps the sand could be cleaned and laboratory experiments disclosed that by first treating the sand with hot 30 percent NaOH and then hot 30 percent HCL the sand could be cleaned, but such a treatment would not be practical as we would only have 10 inches of sand when we got through instead of 30 inches, the balance being dissolved. Owing to the financial condition of the city it was impossible to renew the sand immediately. We installed, therefore, some ammonia equipment, bought some ammonia and some activated carbon, and hoped that by raising the pH from 7.8 to 8.3 and using a 4 to 1 ratio of chlorine to ammonia and plenty of activated carbon, we could get through the winter. The raising of the pH from 7.8 to 8.3 helped but did not entirely eliminate complaints of red water. By raising the pH to 9.4 all complaints vanished, except on dead ends, and the cure for this has been found to have the water leaving the plant at a pH of 9.4 and to use a ratio of chlorine to ammonia of 4 to 1.

TASTES

The presence or absence of tastes indicates poor or good housekeeping. And while we are on the subject of good housekeeping, sanitation, etc., I wonder how the water works industry compares with some of the other industries. Take the soft drink plant. In some states the law requires that the ceiling and walls of the bottling room must be white, the bottles must be washed and sterilized before being filled, and all equipment washed and sterilized at the end of the day and before starting up in the morning. The employees are required to be dressed properly and to wash their hands before starting work. These same regulations apply to the canning industry, the dairy, the brewer, and in fact to all food or beverage establishments except water. Just because water will not sour as milk or ferment as fruit juices is no excuse for not handling it in just as sanitary a manner. Pre-chlorination should be universally practiced; all windows on mix houses should be screened; settling basins covered; the windows and doors to the filter room should be screened; the filter room painted white; the filter walls should be perfectly smooth to facilitate cleaning; and the sand kept perfectly clean and sterile.

We hoped to get through the winter by using ammonia and plenty of activated carbon. We did, but complaints on tastes and odors were numerous. Early in February, thanks to a C.W.A. project,

we started renewing the sand. The effluent from a filter with new sand had zero color and only a very slight taste, while one from the old sand had a color of 20 and a very earthy disagreeable taste. After all the filters had been renewed, the filter walls wire-brushed, etc., the manholes on the distribution system under the filters were removed and from 8 to 32 wheelbarrows of sand and muck were removed. This improved the water. Then the grit chamber, mix house, and settling basins were thoroughly cleaned. The water again improved. Then the clear wells were cleaned, and from that time on, taste and odor troubles vanished. Before the thorough housecleaning it was impossible to pre-chlorinate on account of tastes. Now we have used as high as 14 pounds of chlorine per million gallons for several days at a time when the river was running 100 to 1000 B. Coli per c.c. and not the slightest taste was produced. Incidentally, I think this was the first time the clear wells were cleaned since the plant started.

Because the river water usually contains from 1 to 7 parts of iron and 2 p.p.m. of manganese, we use iron salts for a coagulant instead of alum. When the river is acid, as it is about one-third of the time, we use soda ash with the lime. We pre-ammoniate and pre-chlorinate using a 1 to 4 ratio as we prefer to have a sterile water all through the purification process. We post-chlorinate using 2 pounds per million gallons as a safety precaution.

Thanks to the Federal Government, through the E.R.A., with soap, steel brushes, paint, etc., we have transformed the years of accumulation of dirt, rust, etc. into, well, you can judge for yourself when you see the plant.

In conclusion, we list as improvements:

1. By raising the pH from 7.8 to 9.4, we have changed from a corrosive to a non-corrosive water by actual tests.
2. By adopting ammonia, we have eliminated dead end troubles and phenol tastes.
3. By adopting activated carbon, we have controlled odors and rendered the sludge inert.
4. We have increased the wash water rate by 25 percent and hose the filter walls down at each wash.
5. We use soda ash when the river is acid, or nearly so.
6. We adopted pre-chlorination.
7. Tastes and odors can be controlled by sanitation and good housekeeping.

(*Presented before the Central States Section meeting, August 23, 1934.*)

RECENT ADDITIONS TO THE SACRAMENTO FILTRATION PLANT

By Carl M. Hoskinson

(Chief Engineer, Division of Water, Sacramento, Calif.)

The original design of the pretreatment works for the Sacramento Filtration Plant provided a double-decked, reinforced concrete structure with aeration field and raw water storage above and sedimentation basins below. The aeration field comprised 420 aeration nozzles of the Sacramento Type, mounted over a gravity type primary sand sedimentation basin which was about twenty feet deep. From this point the water flowed into the upper raw water storage basin 7 feet deep by 191 by 270 feet in plan with a capacity of about 2.3 million gallons. From this basin raw water was admitted to four circular mixing tanks 44 feet in diameter by 22 feet deep, into which alum was introduced and floc produced by the mixing action of long paddle arms and plate paddles revolved at a maximum speed of about 2 r.p.m., these paddles being rotated by hydraulic ram type engines operated by water power from the force mains.

Water then flowed to three sedimentation basins in series, each of these basins being located directly under the raw water storage basin and being about 12 feet deep below invert of inlet gates. The total depth of each of these sedimentation basins was about 21 feet and the first basin was of approximately 0.95, the second of 1.9 and the third of 3.8 million gallons capacity. The water traveled in each basin an approximate distance of 350 feet between inlet and outlet gates, the velocity in each basin being progressively reduced in the inverse ratio to the basin capacities.

From the third basin the settled water passed to the rapid sand filters ready for final clarification. Experience with these basins which were designed for a load of 32 to 35 million gallon daily rates indicated that they functioned satisfactorily at these rates and up to 40 m.g.d. rate, at which rate the pretreatment works were overloaded. The original filter installation consisted of 8 rapid sand filters of 4 m.g.d. rating each, and this was soon proved to be inadequate after the commencement of the plant operation in 1924. In 1927 a bond

issue provided for increase of filter capacity to 16 filters of 4 m.g.d. capacity. This addition left the old pretreatment works as the "neck of the bottle" with a maximum satisfactory pretreatment capacity of about 40 m.g.d. rates and, in addition, structural troubles developed early in floors and walls of the old works. It was only by very careful operation that they were nursed along through the intervening years to function at all.

Accordingly, after one failure to pass a bond election, a program of public education to the needs of the City for new and larger pretreatment capacity was instituted by Jas. S. Dean, City Manager, and a bond issue for $480,000 was passed on March 10, 1931, to provide new pretreatment works of 64 m.g.d. capacity. Design was immediately started under the supervision of Fred J. Klaus, City Engineer, by Henry D. Dewell, consulting structural engineer, and Harry N. Jenks, consulting sanitary engineer, for the new project. First contracts were let in the summer of 1931, and the plant was accepted by the City in December, 1932, and after some preliminary try-outs was placed in regular operation on February 3, 1933, under direction of R. E. Mittelstaedt, Superintendent of the Division of Water.

NEW WORKS

The new pretreatment works are also built of reinforced concrete, but are radically different in design from the old plant, the principal difference being enlargement and additions to aeration fields, elimination of raw water storage, change in mechanical devices for producing floc in mixing tanks, and substitution of mechanically cleaned clarifiers and shallow surface type of sedimentation basins for the deep basins previously used. In the old basins, it was necessary to allow the sludge to accumulate over long periods of a year and sometimes more before they could be drained and cleaned out by flushing with fire hose, but in the new basins continuous mechanical cleaning was provided for. In order to reduce the soil load and for reasons of economy, the new basins are nowhere, except in the case of the mixing tanks, of a greater depth than 10 feet, whereas the total depth of the old basins was some 28 feet. The new structure is supported on columns above ground on a composite pile foundation of nearly 1900 driven piles. The total capacity of the new basins is about 3 million gallons, exclusive of mixing tanks of about 1.7 million gallons capacity. The plant is designed for pretreatment on the basis of 1½ hour retention period for 64 m.g.d. flow.

Detritor

The first step in the clarification process in the new basins is taken when the raw water is delivered at the south end to a detritor basin 50 feet by 50 feet in size with a side solution depth of 5 feet when filled to within 15 inches of freeboard. In this basin a Dorrco Detritor cleaning mechanism is installed guaranteed to retain and collect at a 64 m.g.d. flow, 90 percent of suspended matter at 4 feet depth in the basin of a separation size of plus 100 mesh, or plus 0.15 millimeter. The cleaning mechanism is guaranteed to remove this material and have a capacity of not less than 65 cubic yards per 24 hours. The detritor moves the collected material to a drop bottom or sump on one side from which point it is picked up by a Dorr "classifier" and drawn up to a chute, down which it is dumped to the ground below the detritor.

Aeration fields

From the detritor the raw water passes to either or both aeration fields located on each side of detritor. Each of these aeration fields is provided with 288 Sacramento Type Spray Nozzles mounted on 12-inch pipes. Water may be passed through these nozzles for aeration, from which it falls on a sloped corrugated concrete slab which gives the additional effect of stream flow aeration. As an additional feature to allow additional aeration when necessary, there are installed 96 mushroom outlets in the floor slab of each aeration field through which air may be pumped under the discharge of the nozzles at a rate of 20,000 cubic feet of free air per minute by Sturtevant blowers mounted below the slab of the aeration fields and feeding air to the mushroom outlets through a galvanized air duct system installed below the slab. In the event that aeration through the spray nozzles is not considered necessary the water may be passed directly on to the sloped corrugated slab of the aeration fields, giving a small reduction in the pumping head of the low lift pumps.

Mixing tanks and alum feed

From the aeration fields the aerated water passes into a collecting channel from which it may be admitted to the circular mixing tanks in one or more of three places, namely, into No. 1 tank, into No. 4 tank, or into the channel between Nos. 2 and 3 tanks, or the tanks may be bypassed completely and the water passed directly to the clarifiers. The aluminum sulfate or alum syrup ($Al_2(SO_4)_3 \cdot 18H_2O$)

used as coagulating medium may be applied into the 66-inch steel raw water line ahead of the detritor by use of a special ejector, or it may be applied in any one or all of the four mixing tanks directly from a 4-inch cast iron line passing directly over the tanks with special plug cocks near the center of each tank. The four mixing tanks are 56 feet in diameter by 23 feet deep, and the raw water in moving through the tanks passes in at the top and out at the bottom, or vice versa, as it moves from tank to tank. Water may be passed for alum application and floc formation through all four tanks in series, through a two-pair series-parallel combination or through a single pair of tanks in series with the other two tanks cut out.

Mixing of alum syrup with the raw water is accomplished in each of the mixing tanks by a special mixing pump which comprises a large double suction pump runner 8 feet in diameter over discharge ports by 14 feet $\frac{1}{2}$ inch in length. Each discharge port is $8\frac{1}{2}$ inches wide and the pumps are designed to handle 20,000 gallons per minute against a total head of one and one-half feet of water. The runners are so designed as to be operated equally well in either direction. These pump runners are mounted vertically at the centers of the tanks on 5-inch steel shafts which extend up through the steel bridge framework to the speed reduction gears and driving motors. Pumps are driven by vertical 25 horse power, 210 volt, 3-phase, 60-cycle, 4-speed squirrel cage induction motors operating at synchronous speeds of 1200/900/600/450 r.p.m. and driving the pumps through speed reducing gear sets of 40:1 ratio at available pump speeds of approximately 29, 22, 14.5 and 11 r.p.m. Control arrangements are installed for driving the pumps at any of these speeds and in either direction.

Clarifiers

From the mixing tanks the coagulated water is carried in any one or a combination of three possible concrete distributor channels to two clarifier basins each 100 feet square by 10 feet deep. In each basin a Dorr traction clarifier is installed to scrape the settled sludge from the sloping floor of the clarifier to a collecting hopper and 8-inch drain pipe at the center. Water may be admitted into either clarifier at either side through one row of 24 and one row of 23 baffled openings each 18 inch by 18 inch in size, or a total of forty-seven 18 inch by 18 inch baffled inlet or outlet openings on east and west side walls of clarifiers with 26-inch by 26-inch baffle plate over each opening. Gate arrangements are such that the two clarifiers may be operated

in series with all water passing through both clarifiers or the two clarifiers may be operated in parallel.

Surfasettlers

After partial clarification the water passes from the clarifiers through collecting channels to the surfasettler inlet channel which distributes it to the surfasettlers for final clarification before filtration. The so-called surfasettlers are four in number, each comprising a rectangular flat bottomed concrete basin 44 feet wide by 145 feet 6 inches long by 9 feet deep. In each of these basins is installed a galvanized structural steel frame work with clear floor space for cleaning mechanism, which supports 24 rows of #24 gauge corrugated galvanized steel sheets each 8 feet 4 inches long with 2½-inch corrugations and laid on the frame work at an angle of 45° with the horizontal in continuous courses like roofing. The function of these sheets is to increase the available area of sedimentation about 41 percent above the effective area of a flat surface, in addition to the area of the floor, the theory being that sludge depositing on the inclined sheets would soon slide off to the floor as more sludge settles over it.

In each of the surfasettlers there is installed a complete equipment for sludge removal which is of the "straightline" sludge collector type, as manufactured by the Link-Belt Co. This equipment, operated by a 2 horse power motor, moves at the rate of one foot per minute across the floor slab, scraping the sludge from the north to the south end where it is collected and discharged into a hopper from which it passes in an 8-inch pipe line to the sludge pump house for recirculation or disposal. On each side of each surfasettler and adjacent to inlet and outlet channels is a thin baffle wall formed by guniting the reinforced end of the steel frame supporting the galvanized plates and the sludge removing equipment. In this wall are two rows of inlet and outlet baffled ports, with 25 ports in each row or a total of 50 ports in each wall. Each port is 10 inches square, the lower row of ports being located 2 feet 9 inches from floor line to port center, and the upper row the same distance from top of wall, leaving a space of 3 feet 6 inches between center lines of upper and lower rows of ports. The water passes through any one or any parallel combination of the four surfasettlers, the route being across the short, or 44-foot width of the surfasettler and parallel to the plane of the inclined plates. There is no provision for operation of the surfasettlers in series, but any one or more may be cut out of service at any time for dewatering, special cleaning or repair work. From the

surfasettlers the water passes in a common effluent channel to a diverting chamber where it may be turned into either or both groups of 8 rapid sand filters.

Sludge pumps

Near the mixing tanks is erected a sludge pump house into which 8-inch drain lines from each clarifier and from two pairs of surfasettlers are laid and in which valve settings and pumping facilities are provided so that the sludge from the clarifiers and surfasettlers may be returned to the river with wash water from filters or may be drained onto low ground for fill, or it may be picked up by a vertical sewage type pump operated by a vertical two-speed motor at 690 r.p.m. and pumped for re-circulation at a rate of 1500 or 800 g.p.m. to the incoming 66-inch raw water line or to any one of the four mixing tanks, the intention being to make use of returned sludge from either clarifiers or surfasettlers to assist in coagulating and settling the incoming water. The returned sludge passes through orifice metering plates in the return lines with manometer indicators on pump floor for indication of flow. In the sludge pump house is also mounted a Republic indicating and integrating flow meter connected to Venturitube on the 66-inch raw water supply line, and this master meter also controls indication of rate of raw water pumpage at the coagulant plant and in the filter gallery.

Lime treatment

In January, 1933, the Division of Water built a storehouse and feeder provision for hydrated lime. This equipment comprises a frame structure with an upper floor providing storage for thirty tons of lime, which is purchased in paper bags, and 10 cubic feet feeding hopper located on floor level. Below and at ground level is located a Wallace & Tiernan Type B Dry feeder, with capacity range from 7.5 to 450 pounds per hour. Lime may be fed into the applied or filtered water from this point. Present practice has been to feed lime into filtered water line between filters and filtered water basin. The Sacramento water does not appear to need lime treatment except during part of the winter season when pH readings are below 7. Treatment was applied for a period of about six weeks early in 1933, raising pH readings from about 6.6 to 9.0 or 9.2.

OPERATION

The operating results to date are not considered to be conclusive as to the possibilities of the pretreatment works as they are based on

only eight months of operation, largely during a period of extremely low water and heavy summer load, and as the plant went into immediate operation on completion without any preliminary experimental operation, any later modifications or experiments in operation were of necessity governed by the fact that the water being treated was going through the complete process of clarification and on to the consumer, and it has been necessary to take care not to try any radical nor revolutionary measures. Much more complete and satisfactory operating results will be obtained after full advantage has been taken of the opportunity afforded by time and decreased load conditions to make alterations in methods of treatment. With these qualifications in mind a brief statement of the operating results to date are set forth in the succeeding paragraphs.

Detritor

The detritor appears to have functioned well during the operating period, as large quantities of sand have been removed which were apparently of size down to the fineness specified, though no exact check has been made on sizes removed. The detritor is operated at least once per day as necessary and continuous operation is in order whenever the quantity of sand deposited makes it necessary.

Aeration fields

Aeration fields have been in practically continuous service, using the spray nozzles. During July, the fields were shut down and washed off with hose and allowed to dry in the sun to kill the growth of algae which had become offensive. To date the air circulation system with motor operated blowers has not been used as the quality of raw water has been good, being nearly always saturated with oxygen and not having any offensive odor.

Mixing tanks and pumps

As the type of mixing pumps installed is new for the purpose of accomplishing necessary contact and coagulation, considerable experimenting has been carried on to find the best method of producing desired results. This involved passing of water through the tanks in practically all possible flow combinations, dosing alum ahead of and subsequent to aeration and alteration of discharge ports of mixing pumps to decrease quantity of flow through the pumps. The present method is to feed the alum into No. 4 mixing tank with No. 4 pump throttled and operating at full speed. From No. 4 tank the water

passes in series through No. 3 tank with throttled pump operating on second speed, and then on through Nos. 2 and 1 tanks where mixing pumps are shut down.

Clarifiers

Efforts have been concentrated here to discover the most efficient means of operating the two clarifiers to produce maximum sedimentation. At present it appears that the most satisfactory results are obtained by operating the two clarifiers in series, trial parallel operation not having produced as satisfactory results. Experiments are under way on the proper method of baffling inlet and outlet ports to produce proper distribution over the clarifiers and uniform speed of travel of coagulated water across the clarifier basins. Results to date indicate that closing of entire lower row of baffled ports on outlet walls and a variable rate of flow on inlet side through throttled ports will give best results, but experiments are not conclusive on this point. The clarifier cleaning mechanisms have functioned satisfactorily with the present operating practice of cleaning clarifier basins twice weekly.

Surfasettlers

It was found necessary to close four 8-inch by 18-inch equalizer floor ports on outlet baffle walls between surfasettlers and effluent channels and desirable to close the lower row of baffle plates on outlet walls entirely, thus taking settled water out only through upper row of 10-inch baffled openings which are located with centers 6 feet 3 inches above floor line. All inlet ports remain open and baffled. This method resulted in better sedimentation and allowed operation of the cleaning mechanism with the basins in service. The cleaning operation by the straightline apparatus has been found to be necessary on an average of only once a week. Once since starting operation in February, all surfasettlers were drained one by one and thoroughly cleaned by washing down with three or four 1-inch hose streams, thus removing considerable sludge and algae growths that could not be reached by the mechanical cleaners.

Sludge pump

The sludge pump has not as yet been used for re-circulation of sludge to the incoming water and the control house has been used only for controlling process of draining clarifiers and surfasettlers.

(*Presented before the California Section meeting, October 26, 1933.*)

A NATIONAL WATER POLICY[1]

ABSTRACTED BY MARTIN E. JANSSON

The use and control of water resources presents a bewildering array of problems, some technological, some economic, some social, in which, without a guiding principle, it is easy to lose one's way. The vastness of our country, the wide range of climate and topography, the abrupt seasonal changes affecting most of our watersheds, all tend to make the formulation of a national water policy difficult. At the same time they make it essential. Nothing short of a national policy can deal effectively, justly, and democratically with the situation.

It is no longer possible to regard either water or land as purely private property, unaffected with a public interest. Whatever the legal rights, no owner has the moral right to waste a national resource or to put it to uses which are generally harmful. He is not entitled to burn his own forests, allow his own land to be forever impoverished through the washing away of the fertile topsoil, or permit his streams to contribute an unnecessary drop to a major flood.

Similarly, no neighborhood has a moral right to follow water policies which will injure other neighborhoods, nor has any State or region a right to impair the general good. The Golden Rule is no fantastic dream in the use and control of water. It is the only rule that makes good law and good policy.

PRINCIPLES AND POLICIES OF USE AND CONTROL OF WATER RESOURCES

The approach

The problem of formulating these policies is an engineering problem; not merely of physical but of cultural engineering—of planning a future civilization. All that engineering has taught us in respect to planning must be brought to bear on this great problem.

The key to the beneficial control and use of the waters of the coun-

[1] An abstract of the Report of the Water Planning Committee of the National Resources Board. The report was made public on January 18, 1935. —EDITOR.

try is to be found in the recognition of certain unities. Among them is the unity of human interests in the use and control of waters. For a time in the period of early settlement and sparse population, the individual community's handling of waters in its sector of a system may be entirely beneficial to itself and without injury to other communities. But when settlement becomes intensive and the population relatively dense, the increase of uses of water and of claims on a system changes the situation completely. The local benefits that at first result from individual community acts come gradually to be accompanied by disadvantages to other communities; and eventually it frequently happens that the aggregate of collective disadvantages outweigh the aggregate of localized benefits. Then collective interest emerges; interest in unified plans for developing the use and control of a system, in unified physical engineering, and in unified financing.

It has been the custom generally to approach a water factor as presenting only one specific problem of control or use; for instance, elimination of a flood hazard, or navigation, or irrigation, or power. Study of many situations indicates, however, that frequently a combination of factors is such that achievement of some particular objective may be promoted by combining other objectives with it. Usually a project is conceived because of some hazard or some one desired use; but if a large view is taken it becomes apparent that other uses are potential and should be included in the project, in order, on the one hand, to secure the greatest total benefit from the national resource, and, on the other hand to make the cost of each component benefit less than it otherwise would be.

Lines of action—basic considerations

Many individual water projects have come to the attention of the committee; in most instances the supporting data have been incomplete and in many instances they have been inadequate. Some of the lacking data are of a purely hydrologic nature; some pertain to the cultural life of a region concerned; some pertain to the particular physical characteristics of the project itself. This experience indicates the needs for various kinds of continuous researches and of investigations.

Second, not unrelated to the collection of data recommended above, there should be as completely and fairly detailed an inventory as is practicable of all the water resources of the country—rivers, lakes, ponds, swamps and marshes, and underground stores. Water

resources should be labeled in respect to their quantity and more important qualities.

Third, there should be a continuous investigating of possible project areas and of promising specific projects. This is particularly essential if public works that include development of water resources are to be held quickly available as a gap-filling activity to maintain a more stabilized social trend.

Lines of action—phases of the water problem

Underground water. The water which passes beneath the surface of the ground by percolation is of great importance to man. All vegetation depends upon soil moisture, and the water supply of one-half of the people of the United States is supplied from ground water through wells.

There is little evidence of serious depletion of these waters in the humid regions of the East and South, although the allocation of pumpage has become necessary in certain industrial regions, as in New Jersey. In the great agricultural regions of the Midwest and Northwest, however, the depletion of soil moisture and the falling of ground water levels has become critical.

The need for large scale, long time, scientific planning is eminent. Water conservation, land zoning, and improved farm practice are indicated. Important in connection with water conservation is the provision of the best available water for farm, city, and industrial supply. Through the application of geophysical principles to water prospecting, a supply of clear, clean, cool ground water may be secured for many who are now using highly polluted surface waters.

Conservation of underground water from both deep-seated and shallow horizons should be enforced through the proper construction of wells, the elimination of waste, and where needed, the determination of preferential usage. This would not only save the pressure and water, but would prevent valuable farm land from becoming "salted" and good roads from saturation.

Water in Streams. The increase of demand for water and the recurrence of periods of decreased stream flow have given rise to the problem of adequate supplies of pure water for domestic and industrial uses, and the use of streams for carrying away municipal sewage, industrial wastes, and mine wastes has given rise to serious problems of sanitation and public health. These are undoubtedly at present the most serious among water problems.

The solution lies, on the one hand, in extension of sewage and industrial-waste treatment practices, in order to remove or mitigate the principal causes of pollution; and, on the other hand, in restoration of vegetative cover, more rational drainage practices, and especially the establishment of reservoirs to restore and maintain a more even flow of pure water in streams and to improve the quality. Considerable progress has been made in many of the States, but there is little uniformity in the nature of the agencies and their powers.

Irrigation. There is a type of irrigation which merits further study and experiment, and perhaps promotion. That is supplementary, or individual farm, irrigation in humid regions. It is a well-known fact that assured application of water to certain intensive crops at critical times in the growing season is far more beneficial than the chance application of the water by nature throughout the year, even though the total annual precipitation is abundant. And even humid regions experience drought in some seasons or in some years. With supplementary irrigation facilities a farmer can be more certain of his crop, and can expect a larger yield per acre. The problem is one of balancing the cost of supplementary irrigation equipment and operation against gains.

Lines of action—representative problems

In time, the limited water resources of the Nation doubtless will be utilized fully, and even now the further development of large areas, in the humid East as well as the arid West, depends in considerable part on the extent to which water may be conserved by storage. Less certain but more important than the greater and ultimately complete use of water resources throughout the country is their equitable and efficient use, for the greatest good of the greatest number of people. In seeking that goal it is essential in most cases that a given drainage area be studied as a unit; not otherwise can its water resources be developed in an orderly, balanced manner, conducive in greatest measure to the general welfare of the whole area. The water problems of any large drainage basin differ from those of other basins. Obviously, no common plan for the control and use of water in different basins will suffice.

The North Atlantic Basins. Further utilization of waters in the densely populated north Atlantic seaboard is dependent in large measure on the coördinated development of storage for river regulation. The wide range of administrative and technical problems that

are involved in multiple uses of water in this region is illustrated by the Delaware Basin.

Regulation of the main stem of the Delaware River is completely lacking. Sites suitable for the generation of an estimated 165,000 kilowatts of prime power remain undeveloped. Potential water supplies for New York, Philadelphia, and other metropolitan areas are not utilized, and it is only recently that litigation has established the right of New York to 440,000,000 gallons daily from the headwaters. The Delaware below Port Jervis is badly contaminated, and at times of low flow the supplies of water derived from the lower river and bay are further endangered by the intrusion of salt water from the ocean. The possibility of linking a power-generating program with mouth-of-mine units in Pennsylvania and hydro units in New York has not been explored fully. It seems clear, however, that improvement in the use of the Delaware waters will depend on coöperative action involving all three States and the Federal Government.

The same concern of urban populations with the regulation of streams is characteristic of the other drainage basins between the Potomac and the Canadian border. Conditions on the Merrimac resemble those on the Connecticut, which, indeed, may be considered typical of most New England drainages. In general, most of the larger cities have made adequate provision for water supplies, but waste disposal continues to provoke trouble, especially in the lower reaches of the rivers.

The South Atlantic and Eastern Gulf Basins. Birmingham, in the Black Warrier and Cahaba drainages, and Atlanta, in the Appalachicola drainage, are example of cities where there is existing or probable future conflict between uses of water for power and for domestic supply. The water-power developments of the Piedmont also have been located and designed without regard to possible power generation, flood prevention, and low-water control on the coastal plain. In some cases the most feasible regulation in the Piedmond depends on the results of an exploration of ground-water supplies for use by towns and cities of the plain.

The Great Lakes—St. Lawrence Basin. All the important urban areas along the shores of the lakes rely on the lakes for water supply and for waste disposal. The diversion of water to dilute Chicago sewage, long a matter of interstate and international controversy, has been the subject of a decision by the Supreme Court of the United States, but the pollution of the Chicago water supply by sewage from

Indiana cities, of Toledo water supply by Detroit sewage, and of that of Niagara Falls by Buffalo sewage is still serious. Coöperative action aimed at correction of these conditions seems plainly needed.

The Upper Mississippi Basin. In the densely populated southern two-thirds of the region, waste from manufacturing plants and urban areas is a common menace to public water supplies. Effective reduction of pollution centers about the regulation of a single large stream in certain areas, as in the Illinois Basin, and involves many small streams in other areas, as in southern Illinois, where public health has been affected seriously. Consolidation of the water-supply and sewage-treatment works of neighboring municipalities and compulsory treatment of industrial waste offer relief in the congested metropolitan areas. A more perplexing question of control is found in rural areas where decentralized manufacturing plants pollute the sources of water for farmsteads and villages, and injure or destroy fish life.

The Red River of the North.—The regulation of low-water flow for purposes of water supply and waste disposal is a matter of prime concern in the drainage area of the Red River of the North. All towns on the main stem of the river and many on the tributaries suffer from semiannual shortages of water which have become especially severe during the recent succession of dry years. Numerous small lakes in the rolling moraines of the parts of the drainage in Minnesota appear to be susceptible to regulation for water storage, with corollary benefits to recreation.

The Ohio Basins. All the major streams in the Ohio Basin serve both as sources of water for domestic and industrial use and as carriers of sewage and other wastes. At normal stages, the Ohio and its principal tributaries have sufficient water for present purposes, but during low stages the decreased and polluted supplies may cause outbreaks of intestinal disturbances. This situation is being corrected gradually by the installation of water-purification facilities, by the construction of sewage-treatment plants, and by the use of pollution-control works at coke ovens and other industrial plants.

The Southwest Mississippi Basins. Owing to the intermittent nature of the flow of the streams in these basins, problems of deficiency in domestic water supply are becoming increasingly acute. Several storage reservoirs have been proposed for the improvement of these conditions. The Fort Reno and Council Grove reservoirs are of this character.

Recommendations

This report has so far been concerned with principles, policies, and lines of action in their broader aspects. The committee believes, however, that its responsibility would not have been completely met if it failed to make at least a few specific recommendations. It therefore suggests the prompt initiation of certain activities, all of which it considers important because of the time factor involved. They are:

1. Comprehensive surveys, inventories, and records of conditions fundamental for the use and control of water resources.

2. An exhaustive study of the legislative needs for the use and control of water resources.

3. Surveys, studies, and experiments in directive and administrative planning in selected unit areas, in terms of all their natural resources and all of their relevant economic and cultural conditions, with a view to promoting all phases of public welfare in such areas.

4. Comprehensive and detailed studies of promising representative projects of water use and control of undoubted national import. A partial list of projects for such study include the following with a water supply phase:

(a) The Delaware River power, water-supply, and stream-pollution project in New York, Pennsylvania, and New Jersey;

(b) The Potomac River stream-pollution, water-supply, and power project in Pennsylvania, Maryland, Virginia, West Virginia, and the District of Columbia.

(c) The Red River of the North water-supply and flood-control project in Minnesota, North Dakota, and South Dakota.

5. The establishment of a permanent organization for the advisory planning of the use and control of water.

INVENTORY AND USE OF WATER RESOURCES

Sound policies for the conservation and use of the water resources of the United States and sound planning of their orderly development as parts of a well-conceived public-works program must be predicated upon two fundamental premises. The first is a knowledge of what constitutes our water resources, and of how they differ in different regions. The second is the extent to which these water resources have been developed and utilized up to the present.

Considering the importance of water resources to so many phases of our agricultural, industrial, and cultural life, it is worth noting that

hitherto no attempt has ever been made to present a description of the fundamental facts concerning these resources or the extent of their conservation and use for the country as a whole. The water-planning committee therefore undertook to collect data of this character as an essential basis on which to formulate its report and recommendations.

(Then follow chapters dealing in some detail with precipitation, surface waters, ground waters, quality of waters, coastal erosion, drought, flood control, public water supplies, waste disposal, drainage, irrigation, recreation, hydroelectric power, ports and terminals, and conservation by storage. They are illustrated by diagrams, photographs and some seventeen or eighteen lithographed maps of outstanding merit. Only a few of the topics can be touched upon in the following.)

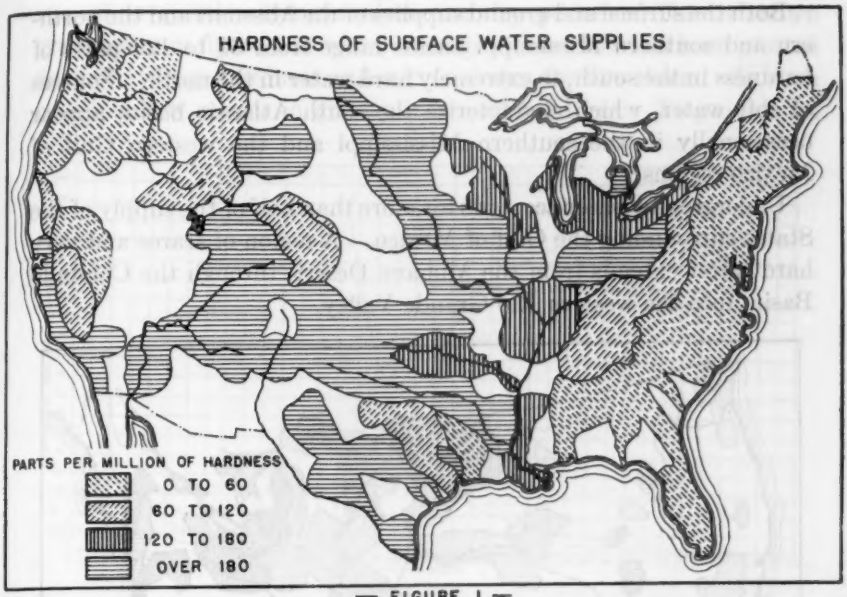
Ground water

Approximately half of the people of the United States use water from wells. Millions of animals, millions of tilled acres, and thousands of industrial plants likewise depend for water, wholly or in part, on underground supplies tapped by wells. Ground water is, indeed, a resource even more important than surface water over much of the country. Unnecessary depletion and pollution of ground waters should cease. Overdraft from year to year in the Santa Clara Valley in California has caused a serious lowering of ground-water levels there. Likewise, in the eastern Dakotas, wasteful use has greatly reduced the flow of the wells tapping the Dakota sandstones.

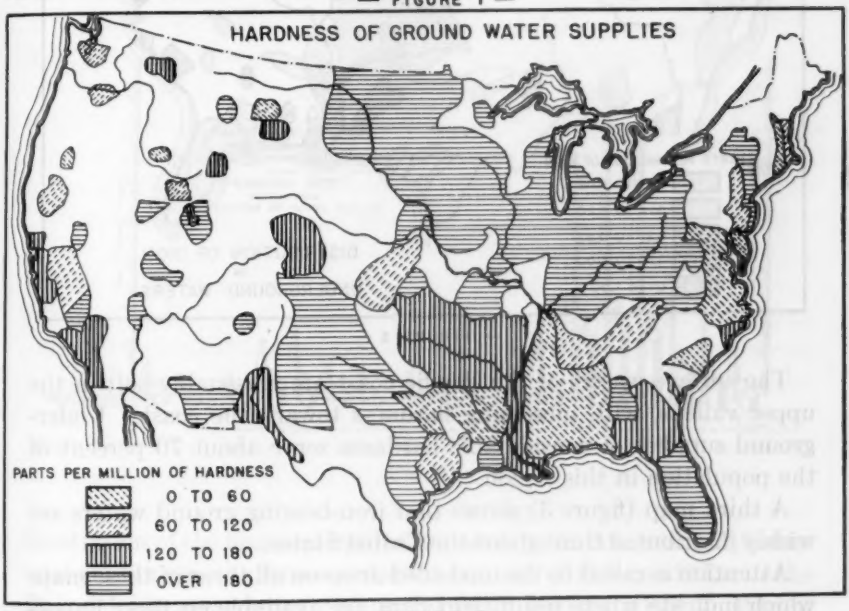
The quality of surface and ground water

The distributions of average hardness of surface water supplies and underground water supplies, respectively, are shown in figures 1 and 2. They show the north and south Atlantic and north Pacific drainage basins generally favored with soft surface water supplies, while the ground water over most of these areas is also of a hardness below 120 parts per million with the notable exceptions of Long Island, a portion of New York, and New Jersey and in part of the Appalacian region and the Florida peninsula.

The surface waters of the Ohio Valley and Great Lakes drainage basins are moderately to excessively hard, increasing toward the north, while the ground waters generally have a hardness above 180 parts per million.



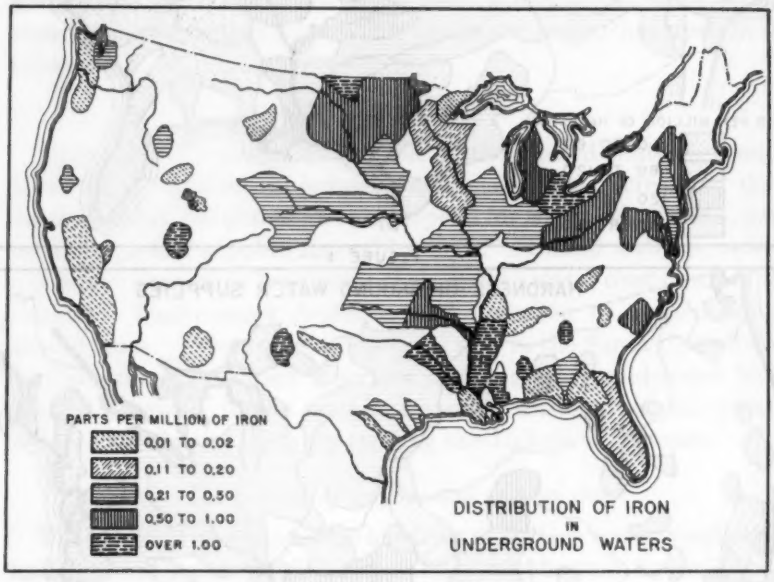
— FIGURE 1 —



— FIGURE 2 —

Both the surface and ground supplies of the Missouri and the northern and southern Mississippi basins range from 60 to 120 parts of hardness in the south, to extremely hard water in the north. Sources of soft water, which characterize the south Atlantic basin, appear occasionally in the southern Mississippi and the western Gulf of Mexico regions.

Underground water accounts for more than half of the supply of the States surrounding the Gulf of Mexico. A region of scarce and very hard water extends from the Mohave Desert, through the Colorado Basin, into the western Rio Grande Valley.



— FIGURE 3 —

The surface waters of the Pacific coast are reasonably soft in the upper valleys, with increasing hardness toward the coast. Underground supplies of considerable hardness serve about 70 percent of the population in this region.

A third map (figure 3) shows that iron-bearing ground waters are widely distributed throughout the United States.

Attention is called to the unshaded areas on all three of these maps which indicate where insufficient data are available on these important factors in the quality of water.

The quality of surface waters which are subject to fluctuations in

run-off is greatly depreciated during dry periods. This is shown graphically in figure 4 in which average stream flow has been plotted against average hardness and curves drawn for five rivers. In each case low flow results in greatly increased hardness. To provide an

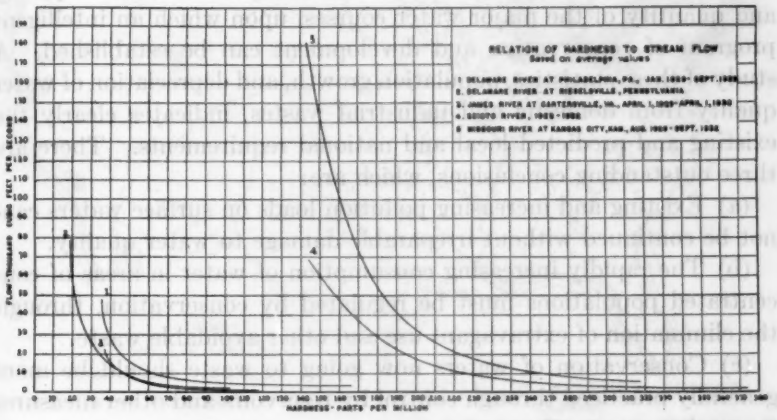


FIG. 4

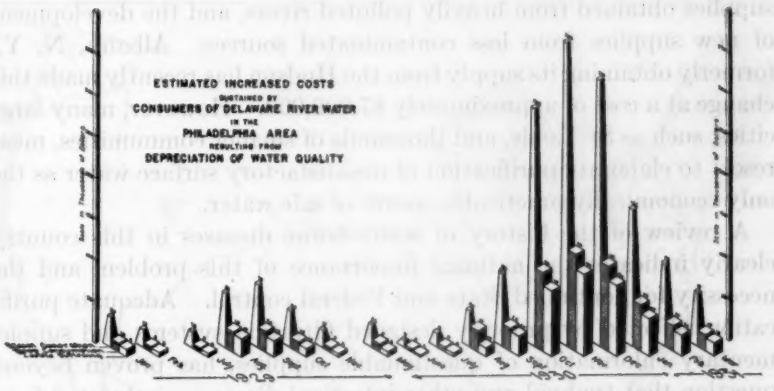


FIG. 5

illustration of the financial burden imposed on the domestic and industrial consumers, the losses sustained because of this condition in the Philadelphia area during the period from January, 1929 to March, 1931 have been plotted in figure 5. It has been estimated that the depreciated quality of the Delaware River imposed an added financial

burden on water consumers in this district of at least $6,500,000 from 1929 to 1933, inclusive.

Public water supplies

There is much statistical information available on both the quality and quantity of the major water courses, upon which an intelligent program of conservation and development can be established. A study of these statistics, population growth, and depreciation of water quality from domestic and industrial wastes, indicates clearly the existing and predicted local and national requirements. There are three outstanding conclusions, which are:

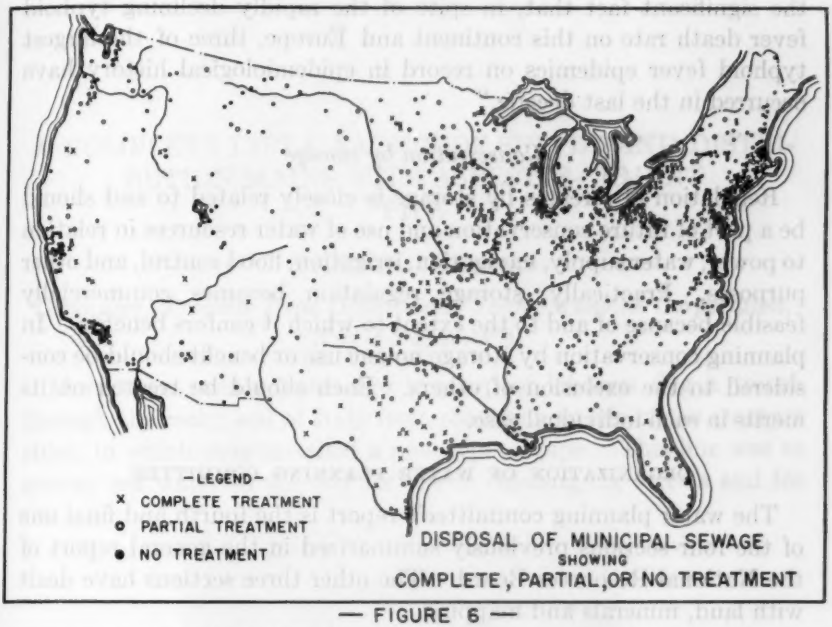
(a) Existing and increasing pollution loads on surface waters cannot be continued without irreparable damage to water quality.

(b) The rapidly increasing consumption of water in areas of concentrated populations must be regulated by conservation, through the elimination of extravagant use and other avoidable waste.

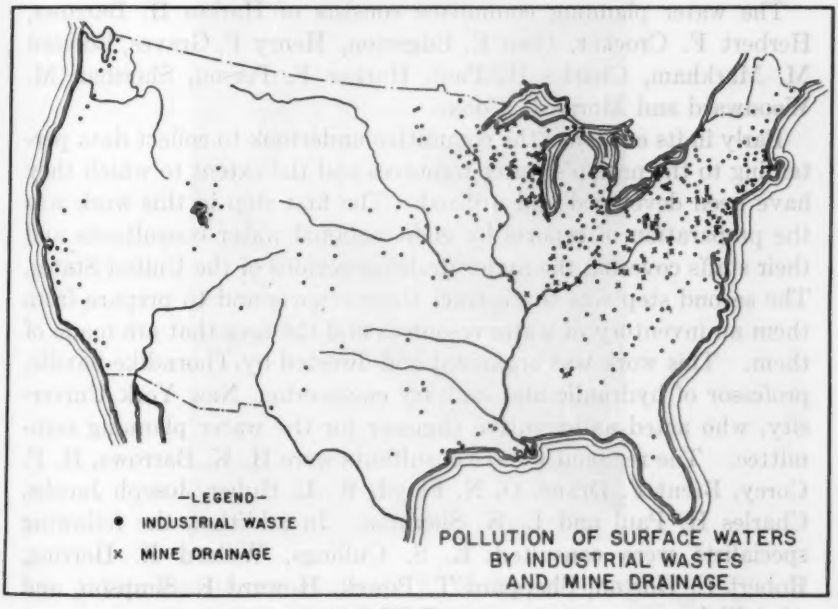
(c) Conservation of waters now going to waste should be more generally practiced through control by reservoirs and other measures to regulate stream flow.

There has been a distinct trend toward abandonment of the older supplies obtained from heavily polluted rivers, and the development of new supplies from less contaminated sources. Albany, N. Y., formerly obtaining its supply from the Hudson has recently made this change at a cost of approximately $7,000,000. However, many large cities, such as St. Louis, and thousands of smaller communities, must resort to elaborate purification of unsatisfactory surface water as the only economically practicable source of safe water.

A review of the history of water-borne diseases in this country clearly indicates the national importance of this problem and the necessity for continued State and Federal control. Adequate purification, effected by properly designed filtration systems and supplementary chlorination of questionable supplies, has proven beyond question that typhoid and other intestinal diseases, contracted from the use of contaminated water supplies, can be eliminated. It should be borne in mind, however, that typhoid fever and other water-borne diseases are not vanishing calamities, but are merely controlled diseases which may recur at any time, if there is a break-down in the operation of water purification systems. This is well illustrated by Wolman and Gorman, who state, "There should be ample warning of the importance of rigid administrative control of enteric disease in



— FIGURE 6 —



— FIGURE 7 —

the significant fact that, in spite of the rapidly declining typhoid fever death rate on this continent and Europe, three of the largest typhoid fever epidemics on record in epidemiological history have occurred in the last decade."

Conservation by storage

Regulation of streams by storage is closely related to and should be a part of future conservation and use of water resources in relation to power, water supply, navigation, irrigation, flood control, and other purposes. Practically, storage regulation becomes commercially feasible because of and to the extent to which it confers benefits. In planning conservation by storage no one use or benefit should be considered to the exclusion of others. Each should be treated on its merits in each individual case.

ORGANIZATION OF WATER PLANNING COMMITTEE

The water planning committee's report is the fourth and final one of the four sections previously summarized in the general report of the National Resources Board. The other three sections have dealt with land, minerals and mapping.

The water planning committee consists of Harlan H. Barrows, Herbert F. Crocker, Glen E. Edgerton, Henry F. Graves, Edward M. Markham, Charles H. Paul, Harlow F. Person, Sherman M. Woodward and Morris L. Cooke.

Early in its existence the committee undertook to collect data pertaining to the nation's water resources and the extent to which they have been developed and utilized. The first step in this work was the preparation of reports by eight regional water consultants and their staffs covering the major drainage regions of the United States. The second step was to abstract those reports and to prepare from them an inventory of water resources and the uses that are made of them. This work was organized and directed by Thorndike Saville, professor of hydraulic and sanitary engineering, New York University, who acted as executive engineer for the water planning committee. The regional water consultants were H. K. Barrows, H. P. Corey, Brent F. Drane, O. N. Floyd, W. L. Huber, Joseph Jacobs, Charles H. Paul and L. K. Sherman. In addition, the following specialists were consulted: E. S. Cullings, Willard E. Herring, Robert E. Horton, Sheppard T. Powell, Howard E. Simpson, and Abel Wolman.

A COMPLETE INSTALLATION OF SUPPLY AND DISTRIBUTION MAINS WITH ASBESTOS-CEMENT PIPE

By C. A. McGinnis

(Engineer, Transite Pipe Department, Johns-Manville Corporation, New York, N. Y.)

More than twenty years ago a group of laborers dug a trench through the rocky soil of Italy from the ocean to one of the seacoast cities, in which they installed a new type of pipe. This line was to convey sea water to the city for use in cleaning the streets and for

Fig. 1. The Washington Mills, N. Y. Water District Installation of 6-, 8-, and 10-inch Pipe (10-inch Shown Above). The Wm. T. Field Engineers, Inc., Watertown, N. Y., Consulting Engineers

FIG. 2. Simplex couplings and rubber rings are usually placed on pipe before lowering into trench. The position of the rings is predetermined by circumferential scoring on the pipe.

FIG. 3. TWO MEN LOWERING 16-INCH PIPE INTO TRENCH

fire protection purposes. After five years of this service, the line was examined and no sign of deterioration could be detected either on the interior or exterior surfaces. In the meantime, the same type of pipe had been installed in the less severe service of conveying drinking water. The experience of both types of installations led to the extensive manufacture of asbestos-cement pipe, and since that

FIG. 4. ONE MAN LINING UP 16-INCH PIPE IN A NARROW TRENCH

time ten manufacturing plants have been built in the principal industrial countries of the world and sales franchises granted in various other countries. At the present time over eight thousand miles of this type of pipe are in service.

COMPOSITION OF PIPE

In the process of manufacture, asbestos fibre and Portland cement are proportioned by weight, 15 percent of the former and 85 percent

FIG. 5B

FIG. 5A

FIG. 5A, B, C. THREE STAGES OF SIMPLEX COUPLING ASSEMBLY

FIG. 5A FIG. 5B

FIG. 5A, B, C. THREE STAGES OF SIMPLEX COUPLING ASSEMBLY

FIG. 5C

FIG. 6. TAMPING BACKFILL UNDER PIPE

FIG. 7. Simplex couplings permit an angularity of as much as 12° at each joint.

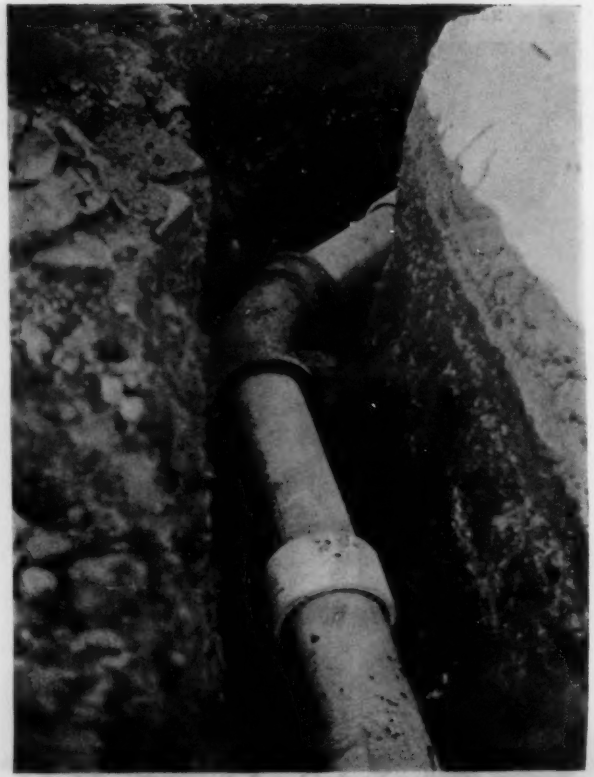


FIG. 8. All-bell fittings, with poured joints, are used on asbestos-cement pipe installations, where fittings are necessary.

FIG. 8. All-bell fittings, with poured joints, are used on asbestos-cement pipe installations, where fittings are necessary.

FIG. 9. New valves are provided with enlarged bells to receive asbestos-cement pipe. Old valves may be connected with an adaptor.

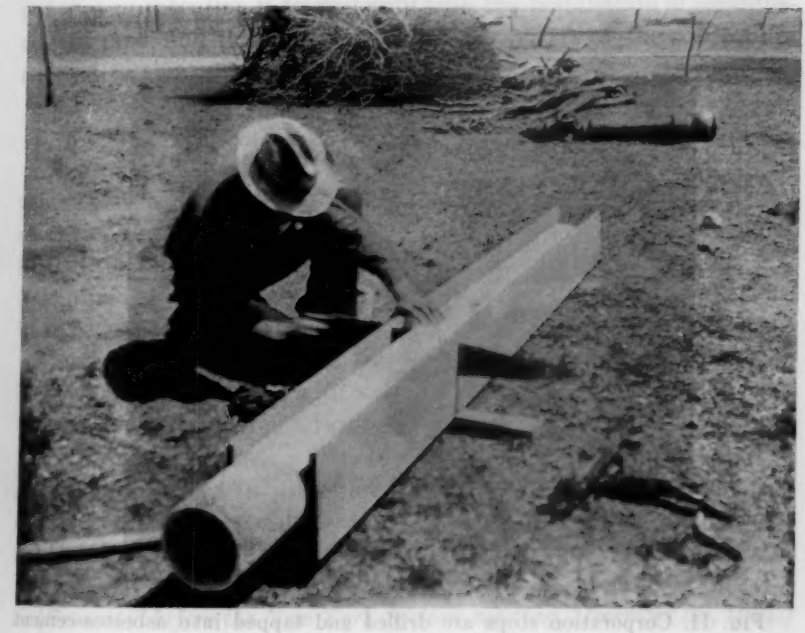


FIG. 10. Asbestos-cement pipe is cut with a carpenter's wood hand saw. A mitre box facilitates this operation.

of the latter, and then the mixture is subjected to enormous pressures. For convenience, in America the classifications of pressure are those used by the American Water Works Association, known as A, B, C,

A

B

FIG. 11. Corporation stops are drilled and tapped into asbestos-cement pipe with standard tools.

D and E—ranging from 100 to 500 feet heads. The pipe sizes provided are from 2- to 36-inch inclusive, the sizes up to 7-inch in 10-foot lengths and the remaining sizes in 13-foot lengths.

An analogy between reinforced concrete and asbestos-cement products indicates that the fibre performs the function of a reinforcing material exactly as steel does in reinforced concrete. The continuity of reinforcing members in asbestos-cement pipe results from the lapping of one fibre over the other so that the effect of a continuous mat of reinforcing is secured, with the additional advantage that the reinforcing material is distributed throughout the entire cross section. Due to the enormous pressure under which the pipe is manufactured, an exceptionally strong bond between the cement and the fibre is obtained, which makes the reinforcing most effective.

ECONOMIC CONSIDERATIONS

In the May, 1934, issue of THE JOURNAL, under the title "Asbestos-Cement Water Pressure Mains" the economic considerations involved in the use of this material are discussed in detail. At that time the relation of asbestos-cement pipe to such problems as tuberculation, soil corrosion and electrolysis was gone into thoroughly. Therefore, our present intention is to deal only with the installation of asbestos-cement pipe, and those interested in other phases of the subject are referred to the previous paper.

INSTALLATIONS

The American experience with asbestos-cement pipe has paralleled that in Europe in so far as types of installations are concerned. Here, as there, the initial installations were in corrosive soils and cinder fills, in the presence of electrolysis and aggressive waters.

During the past three years several hundred American installations have been made, under a wide variety of conditions. The experience we have had to date, backed by the much longer service records in Europe, now provides us with a guide to what may be expected from this type of pipe under practically every service condition encountered in water transportation. (Mr. McGinnis' paper was illustrated with a motion picture which described the manufacture and installation of asbestos-cement pipe under a variety of conditions. The principal subjects treated are illustrated by the photographs reproduced here. —*Editor.*)

(*Presented before the New York Section meeting, December 28, 1934.*)

CHLORAMINE TREATMENT IN DULUTH

By Donald L. Johnson

(Bacteriologist, Water and Light Department, Duluth, Minn.)

The credit for introducing the chloramine treatment in Duluth is due to E. W. Kelly, former head of the Water and Light Department. An emergency arose on August 22, 1930, that required action. For several weeks before this date we had a spell of calm, sunny weather, which produced a marked growth of algae in Lake Superior. Then a strong northeast wind whipped up the algae into our intake. Immediately a strong cod-liverish oil taste developed in the water. To combat this taste, several tanks of ammonia were obtained from a local distributor. The ammonia was then fed into the water at the Lakewood Station in conjunction with our chlorine treatment. A hand valve and scales was the only method of control at first. Within a few hours a marked diminution in taste was obtained. Having overcome this taste problem, it was decided to continue this method of treatment as the tastes in our water had been more or less intermittent before this. An ammoniator was ordered and efforts were then made to keep a close control of this treatment. Our hourly residual chlorine tests and bacterial checks were continued. When the ammonia was first tried heavy amounts were used. After the initial emergency, we found it possible to cut down the ammonia to small amounts and still obtain taste reduction. In order to keep our factor of safety high, we kept our residual chlorine at our previous level, but the ammonia was cut down to a ratio of 1 to 3 with chlorine. This was continued for a month or two until we ran into further tastes.

To reach an understanding of this treatment as a taste preventative, it seems best to consider it as a combination of competing chemical reactions. Undoubtedly the two commonest tastes in our water were free chlorine and the combination algae and chlorine. The addition of ammonia to chlorine in preventing taste interferes with these other reactions. Anything that favors or speeds up the ammonia chlorine reaction will help in taste prevention. Several things according to the laws of chemical reaction favor the speed of reaction

such as thorough mixing, temperature, excess of components, etc. In our practice, we found ourselves confined to the addition of more ammonia as the one method of taste prevention. We had added the ammonia before chlorination and had accomplished through the baffling in our well a good degree of mixing. When the tastes again appeared in our water we were forced to raise the ammonia by small amounts to overcome these tastes. Our control of this was by means of taste tests, raising the ammonia 0.01 or 0.02 p.p.m. at a time until we obtained a taste free water, 0.02 p.p.m. being about the difference between a bad tasting and a good water. This was continued until we reached a ratio of ammonia to chlorine of 1:2, which has continued to overcome all our tastes. During this initial period, the treatment proved its value in taste prevention, high residuals throughout the system and slightly better bacterial quality of treated water.

Due to the haste with which the treatment was installed, it was not thoroughly investigated before starting. Subsequent tests showed there was a definite lag in bacterial reduction with chloramine as compared with chlorine, so that our factor of safety with chlorine was still greater. Within the range of bacterial contamination found in our raw water, it was found to take about two hours to get complete reduction with chloramine, which was accomplished immediately with chlorine. For example, one test sample made up from laboratory tap water plus 1/10000 dilution of B. Coli broth culture and showing a residual of 0.3 p.p.m. chloramine had an initial bacterial count of 6000 per c.c.—at 48 hours 37.5°C. It was immediately reduced to 3300 per c.c. on mixing with the chloramine after 15 minutes down to 160 per c.c., after 30 to 75 per c.c., and finally after 90 minutes down to 3 per c.c. Another test sample made up of treated water with a residual of 0.3 p.p.m. chlorine showing an initial count of 3900 after seeding with B. Coli broth culture was reduced to a zero immediately following mixing. Similar tests showed corresponding reductions in the B. Coli Index. Due to these facts it was thought best to go back to the chlorine treatment until our detention basin was built. This was done on August 14, 1931.

When the detention basin was completed, on February 4, 1933, we returned to chloramine treatment. The basin provides about 4 hours storage before being pumped uptown. This was ample time to accomplish complete reduction of bacteria with chloramine treatment. This basin further increases our factor of safety because double chlorination can be given the water should accidents or tests show

this to be required. Using the same quantities of ammonia and chlorine as before, approximately 1½ pounds ammonia to 3 pounds chlorine per million gallons and residuals of 0.25 p.p.m., we have obtained good results up to date. What few complaints we have had have been those of chlorine taste in dead ends. The only explanation I can give for this is a secondary reaction with release of chlorine when higher residuals penetrated these ends.

DISINFECTION OF NEW MAINS

Disinfection of new mains with chloramine can be accomplished with much less waste of water, chlorine, and effort. Just recently the value of chloramine in this connection was shown when the Morgan Park water system was turned over to the Water and Light Department. The Morgan Park water system consisted of two separate systems, a well water for drinking purposes and a raw river system for fire protection. Under Water and Light Department operation, the two systems are connected and supplied with city water. Our problem was to clean out and sterilize the old fire system. The city water entering Morgan Park has a residual of 0.10 p.p.m. The city water was turned into the fire system and all the old dirty water was flushed out through the hydrants. Residual chlorine and bacterial tests were then taken at several points in the system. Previous laboratory tests had indicated that 0.10 was nearly as good as 0.30 residual in bacterial reduction with the usual lag. Residual chlorine at various hydrants gave tests of 0.05 to 0.10 p.p.m. after flushing, and bacterial tests. After standing several days this gave water up to drinking water standards and several zero counts.

NATURE OF REACTION AND COST

Some interesting questions arise as to the nature of these reactions both in taste prevention and bacterial reduction. Because preammoniation and thorough mixing are recommended for the taste prevention, it appears that ammonia must combine with substances in the water, which would combine with and fix the chlorine. From some comment, I have heard about tastes, my guess is that chloramine treatment produces a better tasting water. This may be due to the union of ammonia with other substances or the chloramine itself. Several explanations have been given of the disinfecting action of chlorine, such as the oxidation, toxic or poisoning, and actual

chemical reaction. The oxidation hypothesis is not accepted now because the addition of ammonia to chlorine increases the germicidal efficiency without using up the available chlorine as quickly. Recent evidence supports the chemical reaction hypothesis, that is, that an actual combination takes place between the available chlorine and the bacterial protoplasms. The important factors in the ammonia chlorine process appear to be pH and temperature values. The lower temperatures in Duluth with a yearly average of about 40°F., and the increased ammonia with a pH of 7.6 combine to give the lag in bacterial reduction.

The total cost of chloramine treatment for 1933, including operation and maintenance, was $1,801.53 or 55½ cents per million gallons treated. This compares with 1932 when chlorine alone was used, with a total cost of $1153.13 or 36 cents per million gallons treated.

(Presented before the Minnesota Section meeting, September 20, 1934.)

PREPARATION OF REAGENTS FOR THE ALBUMINOID NITROGEN DETERMINATION

By I. A. Montank

(Chemist and Bacteriologist, Columbia Heights Filtration Plant, Minneapolis, Minn.)

The need for accurately prepared standards and reagents in making chemical analyses is readily understood. The fact that the preparation of some standards or reagents may require more knowledge, time and painstaking effort than does the analytical procedure which employs them in making a test, is something the chemist alone fully appreciates. Therefore, any improvement in method that will shorten the time factor, make more convenient the handling, reduce the hazards of breakage and preclude possible contamination, is welcomed.

AMMONIA-FREE WATER

Ammonia-free water, which can usually be obtained only by distillation, is used not solely for making the alkaline potassium permanganate reagent as employed in the albuminoid nitrogen determination, but also in the ammonia nitrogen determination. In the latter, when necessary, it is employed in diluting the sample and in the preparation of solutions, such as, the Nessler reagent, the stock of standard ammonium chloride, and the ammonia nitrogen standards. Furthermore, the distilled form may be used to better advantage for the rapid freeing of the apparatus from ammonia than the ordinary distilled water (which usually contains considerable ammonia) as described in *Standard Methods of Water Analysis.*

The common retort type still can be made to deliver an ammonia-free water, containing at most no more than 0.0001 to 0.0002 mgm. of ammonia in volumes of 50 ml. which are insufficient values to affect results. Such a water may be obtained subsequently to operating the sludge free still with the condenser water shut off until the distillate has run steaming hot for about 40 minutes, and then continuing the operation for a like period with the condenser in opera-

tion. The still will then deliver ammonia-free water which can be collected in flasks. The flasks may be stoppered with cork (some grades of rubber stoppers impart color) and stored for weeks and months without the liability of ammonia contamination.

ALKALINE POTASSIUM PERMANGANATE

The two earlier editions, 1923 and 1925, as well as the 1933 *Standard Methods of Water Analysis*, pp. 17 and 18, describe the preparation of alkaline potassium permanganate as follows:

> Boil 1.2 liters of distilled water in a 2.5 liter porcelain dish 10 minutes to drive off ammonia. Add 16 g. of potassium permanganate and stir until solution is effected. Add 800 ml. of clarified 9 N solution of potassium or sodium hydroxide, and ammonia-free water to make up to 2.5 liters. Concentrate to 2 liters. Determine the ammonia in 50 ml. of the reagent and use the result as a basis for correction in subsequent determinations.

The preparation of the reagent described above can be carried out to a better advantage in the following manner:

Place 16 g. of potassium permanganate in a 2 liter, flat-bottomed, Pyrex flask, and add approximately 1.2 liters of ammonia-free distilled water. Agitate until solution of the permanganate is effected. Add 800 ml. of a 9 N solution of potassium hydroxide (Merck's reagent) prepared with ammonia-free distilled water. For this preparation potassium hydroxide is preferred to sodium hydroxide (Merck's reagent) as it will dissolve leaving no residue, and may be added without clarification. Add ammonia-free distilled water to the 2 liter flask (which actually holds about 2.3 liters) until the level of the solution nearly reaches the neck of the flask, making the total volume of the solution approximately 2.25 liters. The concentration to 2 liters may be accomplished by boiling the solution over the free flame, which is placed at the side and near the bottom of the flask. In this way rotatory convection currents are set up, and "bumping" is prevented. Boiling is continued until the solution level reaches a predetermined mark on the label of the flask, giving a volume of 2 liters when the solution has cooled to room temperature. A double trap, consisting of a dilute solution of sulfuric acid (approximately 0.1 N) in one Woulff bottle and followed by another containing ammonia-free distilled water, is connected in series with the flask. The solution is then allowed to cool. Air entering the flask is thus prevented from contaminating the solution with ammonia. The trap is next

removed and the flask securely stoppered. Several lots of the reagent prepared according to this method have been found to be ammonia-free, therefore making unnecessary the determination of ammonia in 50 ml. of the reagent to serve as a basis for correction in subsequent determinations.

In a comparison of the method as stated in *Standard Methods of Water Analysis* and the one here described, it will be seen that the initial step in the former is entirely eliminated in the latter, thus resulting in the saving of considerable time. The work is facilitated by employing an easily managed flask instead of the large, awkward, porcelain dish which had been used previously as a preparation container. Much tedium is spared and time is gained by avoiding the necessity of clarifying the 9 N alkaline solution. Both time and material are saved by eliminating the running of a blank analysis for correction purposes. Finally, by retaining the finished reagent in its preparation flask instead of transferring it to a bottle, the possible loss through spilling and the risk of contamination are obviated.

ABSTRACTS OF WATER WORKS LITERATURE

FRANK HANNAN

Key: American Journal of Public Health, 12: 1, 16, January, 1922. The figure 12 refers to the volume, 1 to the number of the issue, and 16 to the page of the journal.

False Wheeler Filter Bottom Used in New Water Plant. G. GALE DIXON. Eng. News-Record, 111: 317–21, 1933. Filter plant of new Meander Creek supply of Mahoning Valley Sanitary District consists of ten 4-m.g.d. units, operated at 125 m.g. per acre per day, overlying a 1-m.g. clear water reservoir. The underdrainage system consists of false bottom, of Wheeler type, 24 inches above structural bottom. Filtering medium consists of 21 inches of sand with effective size of 0.43 mm. and uniformity coefficient of 1.36, the 30 per cent size being 0.505 mm. Underlying sand is 6-inch layer of coarse silica sand or "torpedo gravel" having effective size of 1.21 mm. and uniformity coefficient of 1.28, and 4 layers of graded gravel totaling 12 inches in thickness. The cost of this type of filter bottom was $1,125 per m.g.d. as compared with $1,216 for perforated pipe system. Ordinary maximum rate of wash will be 36 inches per minute. Filtered water is treated with ammonia and chlorine. —*R. E. Thompson (Courtesy Chem. Abst.).*

Storage Tank Operation to Aid Pressure Conditions. E. F. TANGHE. Eng. News-Rec., 111: 321–2. September 14, 1933. A 1.5-m.g.d. elevated tank, 50 feet in depth, with overflow elevation 175 feet above ground, was recently constructed in Milwaukee to correct low pressures in certain district during sprinkling peak. Tank fills during night and is automatically disconnected from distribution system when full and returned to the line about 5 o'clock next afternoon. Area which was formerly without pressure during sprinkling period now has minimum pressure of 20 pounds per square inch on maximum pumpage days. Another similar tank is under construction, and, in addition, booster pumps will lift water from ground storage tank into system during sprinkling periods. Demand during sprinkling hours is double average rate of pumpage on maximum day of year and 4 times average daily rate.—*R. E. Thompson.*

Ammonia-Chlorine Treatment Yields Nitrites in Effluent. ROBERTS HULBERT. Eng. News-Record, 111: 315–6, 1933. Since applying ammonium sulfate with alum, after prechlorination, at Detroit 3 years ago, Cl demand of filtered water has been unusually high during summer months. Investigation indicates this as due to nitrite production by nitrifying bacteria in filter bed, growth of which is favored by ammonia. Experiments showed that seven

parts of chlorine are used up in oxidation of one part of nitrite nitrogen. If sufficient ammonia is applied to fix all chlorine added after filtration as chloramine, this loss of chlorine will not occur. Interference by nitrite in *o*-tolidin test may be avoided by keeping sample in the dark for 10 minutes after adding *o*-tolidin, as color produced by nitrite requires strong light and period of 20 to 30 minutes to develope. Examination of filter sand showed that most active nitrification occurred in top 6 inches. Sterilization of sand prevented nitrification. Optimum temperature for growth of nitrifying bacteria is 77–86°F., hence difficulty is experienced only during summer.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Rapid Progress on Filtration Plant for Toronto's Duplicate Water Supply. Engineering and Contract Record, **47**: 841–3, September 6, 1933. Considerable progress has been made on new Victoria Park filtration plant, which will ultimately consist of forty 5-m.g.d. filters operated at rate of 105 m.g.a.d. Only 20 filters will be constructed at first. Mixing period of 30 minutes and settling period of 2 hours and 50 minutes are being provided for. Wash water orifices, at 1-foot centers, will be of bronze, inclined downwards at angle of 45° from current in pipes. Top 6 inches of gravel will be cemented. Filter sand will be 30 inches in depth and will have effective size of about 0.5 mm. and uniformity coefficient of 1.5. Filtered water will be superchlorinated and dechlorinated with sulphur dioxide. Pure water reservoir, located under filters, will have capacity of 12 million gallons.—*R. E. Thompson.*

Summary of Principal Unit Prices, 19 Contracts, Colorado River Aqueduct Tunnels. Eng. News-Rec., **111**: 396, September 28, 1933. The Metropolitan District Commission will drive 10 of 29 tunnels comprised in Colorado River aqueduct, which will be 91.13 miles long. Remainder will be carried out by contract, 19 contracts having been let to date. Unit prices for 7 principal items common to each section are shown graphically.—*R. E. Thompson.*

Selecting Pumping Equipment for a Large Water Plant. William C. Rudd and Louis E. Ayres. Eng. News-Rec., **111**: 429–33, October 12, 467–71, October 19, 1933. Details are given of studies which led to selection of motor-driven centrifugals for new Springwells high- and low-lift station in Detroit, with adjoining steam power plant supplemented by tie-line to central station service. Low-lift plant contains 10 pumping units and high-lift plant will ultimately contain 16 units. Methods used in determining combination of units best suited for conditions in the two stations and pump specifications on which bids were asked are described.—*R. E. Thompson.*

Algal Nuisance in Surface Waters. N. J. Howard and A. E. Berry. Can. Pub. Health J., **24**: 377–84, 1933. Factors influencing the growth, death, and decomposition of algae in surface waters are discussed and nuisances caused by such growths in Ontario in recent years are described. Offensive conditions, similar to those arising from accumulations of sewage sludge, occurred at several places as result of heavy growths of *Cladophora* becoming detached from stony formations on which it grows, washing up on shore, and decaying.

Control of such growths by chemical treatment in open bodies of water is difficult and expensive. Nuisance can be prevented by removing accumulations from shore before decomposition begins. Whether such work is public or private responsibility is disputed question. In 1924, prolific growth of *Anabaena* developed in Fraser Lake, imparting bluish green color to water. Coincidently with decomposition of this growth in early fall, about 20 cattle died after drinking the water.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Three 30-m.g.d. Pumps for Montreal's Water Supply. Engineering and Contract Record, 47: 941–3, October 4, 1933. Brief description of 3 New electrically driven centrifugal pumps recently installed in addition to low level pumping station in Montreal. Suitable location for 400-million-gallon reservoir, which would provide 3 days' supply in case of emergency, is being sought.—*R. E. Thompson.*

Powerful Pumping Equipment Averts Conflagration at Cornwall, Ontario. Engineering and Contract Record, 47: 1018, November 1, 1933. Fire on August 7, which lasted 6 hours, destroying 27 buildings and causing loss of $450,000, was prevented from reaching more serious proportions by adequacy of water supply. About 550,000 gallons of water were used in fighting fire.—*R. E. Thompson.*

New "Standard Methods" Shows Growth of Science. HARRY E. JORDAN. Eng. News-Rec., 110: 748–9, 1933. History of "Standard Methods for the Examination of Water and Sewage," 7th edition of which has just been published, is outlined and development of test for *B. coli* group organisms is discussed.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Record Floods in Colorado, Wyoming, and Arizona Formulized. PAUL V. HODGES. Eng. News-Rec., 111: 171, August 10, 1933. Flood-flow characteristics of principal streams in the 3 states were analyzed from existing data. Formulas are given showing relation of peak discharge to various basin areas. —*R. E. Thompson.*

Fundamental Principles of Soil Compaction. R. R. PROCTOR. Eng. News-Rec., 111: 245–8, August 31. **Description of Field and Laboratory Methods.** Ibid., 286–9, September 7. **Field and Laboratory Verification of Soil Suitability.** Ibid., 348–51, September 21. **New Principles Applied to Actual Dam-Building.** Ibid., 372–6, September 28, 1933. Need of more precise procedure for design and construction of earthfill dams led to extensive investigation by Bureau of Waterworks and Supply of City of Los Angeles into suitability of various soils for this purpose. It was particularly desired to find method for determining and limiting softening of earthfill dam that may occur, under certain conditions, if earth becomes completely saturated with percolating water. Investigation resulted in development of system of field and laboratory control designed to secure compaction of soils to density which, by actual test, is essential to obtain required watertightness and stability. Theoretical princi-

ples involved, results of studies made, and application in practice, notably in construction of Bouquet Canyon Dam No. 1 for Los Angeles water supply, are dealt with.—*R. E. Thompson.*

Notable Improvements in Groundwater Development. O. E. MEINZER. Eng. News-Rec., 110: 750–2, 1933. General discussion of relative advantages of ground and surface water supplies and of marked improvements effected in development of ground water supplies for public use. It is estimated that approximately 6,500 of 10,000 public supplies in United States are derived from wells. Nearly 20,000,000 people in United States are served by public, and from 30 to 35 millions, by private, well supplies.—*R. E. Thompson (Courtesy Chem. Abst.).*

Earth Dam for Hartford Water Supply. Eng. News-Rec., 111: 214, August 17, 1933. Unit prices are given from 3 lowest bids received on construction of stream control works and lower portion of Bills Brook earth dam, part of extensive project for additional water supply for Metropolitan District Commission of Hartford County, Connecticut. Dam, located on East Branch of Farmington River, 20 miles north of city, will have ultimate height of 130 feet and length of 2000 feet. It will be a rolled earth-fill, with concrete core wall. Reservoir will cover 4 square miles and have capacity of 30 billion gallons. Dam will be built only to one-third of ultimate height at present. Contract was let for $538,755. Bond issue of $8,600,000 was approved some time ago.—*R. E. Thompson.*

Soil-Bearing Tests for Columbus Water Tanks. JOHN C. PRIOR. Eng. News-Rec., 111: 500–2, October 26, 1933. Soil-bearing tests made in connection with erection of two elevated tanks of 1,021,000 and 2,004,000 gallons capacity, respectively, are described and discussed. Methods of testing and results, and actual settlement observed on filling tanks are given and safe loading formulas are discussed.—*R. E. Thompson.*

Economical Construction for Prechlorination House. Eng. News-Rec., 111: 625, November 23, 1933. Brief outline of low-cost building constructed by Indianapolis Water Co., to house 1-ton chlorine containers and prechlorination equipment.—*R. E. Thompson.*

Progress in Intake Design Revealed by Chicago Crib. MYRON B. REYNOLDS. Eng. News-Rec., 110: 737–9, 1933. Description of intakes built in Chicago since first, completed in 1865, and including Wm. E. Dever crib, now under construction, which is eighth exposed crib constructed in Lake Michigan. Provision has been made in its design for installation of equipment for chemical treatment at intake, if desired. Sanitary precautions include provision for sterilization, or incineration, of all wastes. Latest development is proposed plan for installing equipment at Edward F. Dunne crib for treating water entering shafts at this and at 68th St. crib with ammonia and chlorine.—*R. E. Thompson (Courtesy Chem. Abst.).*

Stream-Pollution Survey Completed in Cook County. Eng. News-Rec., 111: 466, October 19, 1933. Brief details regarding two-year pollution survey of 700 miles of streams in Cook County, Illinois, recently completed by State Department of Health.—*R. E. Thompson.*

Copious Artesian Supply Serves Entire Township. F. J. KEIS. Eng. News-Rec., 111: 627–8, November 23, 1933. Outline of development of artesian water supply of Latham Water District in Albany County, New York, which will cost more than $700,000 and will serve nearly the whole of Colonie Township.—*R. E. Thompson.*

Filters and Metering Proposed for South District of Chicago. Eng. News-Rec., 111: 637, November 23, 1933. Brief details from report recently presented to Chicago City Council recommending construction of 364-m.g.d. filtration facilities and complete metering for southern third of city at estimated cost of $21,140,000, including meters, lake structures, filters, tunnels, and pumps.—*R. E. Thompson.*

New Test Data Aid Quality Control of Gunite. E. P. STEWART. Eng. News-Rec., 111: 558–61, 1933. Additional observations (cf. C. A., 26: 542) made during relining of second reservoir (Woodland) in Syracuse are described in detail. Graphs are given showing compressive strength of gunite placed at various nozzle velocities with 3 sizes of nozzles, and relation of strength to water content and to age of dry mix. Nozzle velocity data given for previous study were found to be in error and corrected data are given in this paper. In present work, using 1¼-in. nozzle, gunite of maximum strength and density was obtained with air velocity of 510 feet per second, with nozzle held approximately 4 feet from work. Decreasing distance between nozzle and work has same effect as increasing nozzle velocity. Average mix employed was 1:13:8, the sand containing 4 percent moisture by weight, which was found the optimum for operation. Strength of gunite increases as water content decreases, but there is a practical limit to dryness of mix (10 percent under, and 9 percent above, reinforcing mesh). Tests showed that strength substantially decreased as period of storage of dry mix increased and therefore storage of not over 1 hour was provided for. Observations indicated that passage through gun has considerable pulverizing effect on soft particles of sand. Reservoir, which has capacity of 125 million gallons, was constructed in 1892–5 and examination had shown concrete lining to be porous. A 1½-inch layer of gunite was applied. Copper expansion joints were provided.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Water Softening by Base Exchange. Edward Bartow. Proc. Iowa Acad. Sci., 38: 151–5, 1931. From Chem. Abst., 27: 1964, April 20, 1933. Popular description of base exchange method of softening and discussion of disadvantages of hard water in household, of advantages of water softener of type mentioned, and of its approximate cost for the home.—*R. E. Thompson.*

Electrically Produced Ozone Offers Promising Results for Water Sterilization. T. Rich. Eng. Contract Record, **47**: 847–8, 1933. Use of ozone for water sterilization is rapidly increasing in France. In 1920, there 20 such installations supplying 46 m.g.d., while in 1930 there were 54, treating nearly 80 m.g.d., exclusive of Saint-Maur plant serving large portion of Paris. Ozone generator is very simple apparatus, consisting of 2 parallel plates, a few millimeters apart, separated by 2 dielectric sheets to prevent sparking. High-voltage, high-frequency current discharge ozonizes air drawn through apparatus, which is mixed with water by means of injector, water subsequently flowing over cascades to remove excess gases. Intimate mixing is essential. Power consumption is about 0.0125 kilowatt-hour per cubic meter, i.e., 18,000 gallons per kilowatt-hour. Modified apparatus has been developed for domestic use.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Separate Roughness Coefficients for Channel Bottom and Sides. Robert E. Horton. Eng. News-Rec., 111: 652–3, November 30, 1933. Formula is developed for coefficient of roughness of composite channels, i.e., channels with different degrees of roughness of bottom and sides, which will vary with depth of flow.—*R. E. Thompson.*

Color Scale for Nesslerization. René Danet. J. pharm. chim., **16**: 68, 1932; cf. C. A., **22**: 2018. From Chem. Abst., **27**: 1965, April 20, 1933. Aqueous solution (A), containing in 100 cc., 0 8 cc. of 10 percent potassium chromate and 22 cc. 10 percent non-dried cobalt nitrate, corresponds to 0.010 gram ammonia per liter, nesslerized. Ten cc. of water to be examined is treated with 5 drops Nessler solution and color compared with 0.5, 1, 2, 3, 5, and 10 cc. of A made up to 10 cc. with water, colorations corresponding to 0.5, 1, 2, 3, 5, and 10 milligrams ammonia per liter, respectively.—*R. E. Thompson.*

New Flow Meter Uses Side Contractions Only. Floyd A. Nagler. Eng. News-Record, 111: 132, 1933. Brief illustrated description of novel type of Venturi meter, called "side-contraction meter," developed at Iowa Institute of Hydraulic Research. Advantages, compared with standard Venturi meter, are: (1) cost less than 10 percent of latter, (2) self-cleansing, accumulation of sediment being prevented, (3) lower loss of head, and (4) functions with pipe only partly filled with water.—*R. E. Thompson* (*Courtesy Chem. Abst.*).

Treatment of Water Supply after Long Beach Earthquake. R. F. Goudey. Eng. News-Rec., 111: 502–3, October 26, 1933. Immediately following earthquake on March 10, Long Beach officials ordered boiling of municipal water for drinking purposes, notices being broadcast every 15 minutes for 2 days, before obtaining knowledge of exact conditions, public confidence in water supply being thus completed destroyed. Survey indicated that while one small area had been isolated, due to numerous breaks, there was no reason to suspect pollution of supply, either at source, or in distribution. In order, however, to restore confidence, it was considered desirable to treat entire system so that residual chlorine would be present throughout city This was effected by means of trailer-mounted chlorinating unit belonging to Los

Angeles. Water was treated with 10.5 pounds chlorine per million gallons, and 0.3 to 2.0 p.p.m. residual chlorine was found in all south and east portions of distribution system within 24 hours. *B. coli* was absent in 50 cc. portions of 70 samples collected from all parts of city. Portable chlorinator used consists of vacuum-type machine with full range of orifices, 10-horsepower gasoline engine, 30-gallon per minute pump, 220/440-volt motor, fittings, etc. Water is drawn from one hydrant to chlorinating machine and discharged into second hydrant by means of hose. Chlorine, in amounts from few pounds to 750 pounds per day, may be introduced into system under pressures up to 450 pounds per square inch. Either electricity or gasoline may be used as source of power, as conditions demand.—*R. E. Thompson.*

The Chelmer and Blackwater Supplies of the Southend Waterworks Company. T. E. HAWKSLEY, E. C. BILHAM, J. F. BEALE, etc. Paper read before Institution of Water Engineers, May 10, 1933. Water and Water Engineering, **35**: 419, 321–333, Special Midsummer Number, 1933. River water after initial purification by sedimentation for 8 or 9 days in open reservoir, built in 2 sections, each containing 30 million gallons (Imp.), is treated with aluminium sulfate and lime in excess of softening requirements and agitated for 30 minutes. Calcium carbonate sludge is settled in primary settling tanks of Dortmund type and water is allowed contact period of about 24 hours with excess lime (amounting from 10 to 20 p.p.m. of calcium oxide), to sterilize it. Excess lime is precipitated as carbonate and partially re-dissolved by carbon dioxide, obtained by burning metallurgical coke in special stoves and applied by high pressure water-operated injector. Water is treated in carbonating chamber with 2 p.p.m. of previously sterilized powdered activated carbon fed through dry-feed apparatus and final purification is effected, after 2 hours contact with carbon, by filtration through 14 rapid gravity sand filters, wash water from which is sedimented for 12 hours and returned for purification. Calcium carbonate sludge containing about 80 percent water is pumped to vacuum operated rotary dehydrating filters, resulting chalk cake being calcined to lime in oil-fired rotary kiln and used repeatedly in process, surplus (nearly 100 per cent) being available for agriculture and building. Results attained comprise reduction of hardness from about 300 to about 120 p.p.m., elimination of 70 to 80 percent of organic matter, and almost complete elimination of bacteria. Out of 1952 samples tested, only 8 showed *B. coli* in 100 cc.; whereas in raw water, *B. coli* is present in 1 cc. Requisite lime excess to give sterilization is ensured by maintaining alkalinity of water in mixing tanks at pH of 12.2 using Brilliant Cresyl Blue indicator, which is olive green at 12.2 corresponding to from 1.5 to 20 p.p.m. excess lime. History of excess lime treatment is given, also observations on difficulties caused by water "turn over" in sedimentation reservoirs with sharp changes of climatic conditions; and on possible increase of magnesia, etc. in lime owing to repeated use.—*W. G. Carey.*

The Stour Supply Scheme of the South Essex Water Company. B. W. BRYAK. Paper read before Institution of Water Engineers, May 10, 1933. Water and Water Engineering, **35**: 419, 334–350, Special Midsummer Number, 1933.

Water consumption having doubled in last 10 years, previous supply from 8 wells in chalk was insufficient. Water is therefore obtained from river and after passing through siphon pipe is pumped to sedimentation reservoir, gravitates in succession to primary rapid filters, secondary filter beds, and filtered water contact reservoir, receiving on its way dose of ammonia and chlorine, and is finally distributed by high lift pumps to three service reservoirs. Sedimentation reservoir has capacity of 31.8 million gallons (Imp.) and watertightness is ensured by 2-foot gravel puddle, consisting of 60 percent clay and 40 percent stone (graded to pass 1¼-inch mesh) carried on 6-inch concrete mat. Primary filtration comprises two sedimentation tanks and 10 Paterson gravity filters, which are capable of treating 12 million gallons (Imp.) per 24 hours. Secondary filter beds follow usual practice, rate of filtration being 3¾ to 4½ million gallons (Imp.) per acre per 24 hours. Descriptions of pumping stations, prime movers and pumps are given; also of ferro-concrete work for reservoirs, filter beds, and pumping stations, with some 16 illustrations and diagrams.—*W. G. Carey.*

The Use of Activated Carbon for Water Purification. P. Smit. Water and Water Engineering, 35: 413, 9–12, January 20, 1933 and 414, 75–77, February 20, 1933. Survey is given of specific properties of activated carbon, and of chemical and physical theories of its action. Carbon of animal origin is most active; but not due to nitrogen compounds. Adsorption theory is favored; products causing diminution of surface tension (colloids, coloring matter, high molecular products) are concentrated at inferface between absorbent and medium and can be partially removed by filtration. Diameter of carbon capillaries is of great influence, and may account for carbon suitable for gas adsorption being unfit for decolorising liquids. According to surface theory, activation effects removal of tarry products, which obstruct surface. Activation by means either of superheated steam, phosphoric acid, or zinc chloride is largely practised. Activity is not always due to freedom from impurity: material either impure, or even of low carbon content, may have good activity. Causes of bad taste and odor of drinking water are discussed and purification of surface water in general by sedimentation, aëration, filtration, chlorination, and storage is reviewed. Purification by activated carbon is then dealt with. Decolorizing tests of carbon on molasses, iodine, methylene blue, etc. are of little value in practice. Revivification comprises washing, steaming, washing with caustic soda and hydrochloric acid, fermentation, and, finally, high temperature in special kilns. Most intensive and rapid water treatment is with powdered carbon, but experiment has been tried in Holland of placing layer of granular carbon 1½ inches thick some distance under surface of sand bed; this filter removes more organic matter and gives great difference in number of bacteria.—*W. G. Cary.*

Tellurium Lead Pipes. Anon. Water and Water Engineering, 35: 420, 397–400, June 20, 1933. Addition of tellurium to lead raises temperature of recrystallization; tellurium lead can therefore be permanently work-toughened for use at ordinary temperature. By adjustment of rolling conditions and heat treatment, tellurium lead sheet can be produced having tensile strength of

2600 to 4000 pounds per square inch. Tellurium lead when extruded is soft, having very refined grain, and owing to manner in which it responds to stress, will undergo unusual amount of distortion before fracture, thus offering enhanced resistance to bursting by frost. Fatigue limit, on basis of 10 by 10^6 reversals without fracture, is ± 0.5 ton per square inch.—*W. G. Carey.*

Some Effects of the Addition of Tellurium to Lead. W. SINGLETON and B. JONES. Engineering, 1933, 135, 317–318. Lead containing up to 0.1 percent of tellurium has increased toughness, tensile tests at very slow rates (0.018 inch per minute) giving ultimate stress 50 percent greater than ordinary lead; with rapid straining tellurium lead is still advantageous, but there is less difference. Pipes of lead and of tellurium lead of similar dimensions were filled with water and repeatedly frozen until bursting occurred. Ordinary lead pipes showed marked local distension after first freezing, with formation of large bulge. Tellurium lead pipes were quite symmetrical after three freezings; failure occurred after five freezings, with moderate local bulge. Hydraulic bursting tests, before and after freezing, further supported superiority of tellurium-lead pipes. Fatigue resistance of extruded lead containing 0.05 percent tellurium determined in Haigh fatigue-testing machine was nearly three times that of ordinary lead. Tellurium lead showed increased resistance to corrosion by sulphuric acid as compared with ordinary lead. Manufacture presents no difficulties in preparation of metal, or in cold rolling or extrusion. Tellurium confers improved properties on various alloys of lead with other metals.—*W. G. Carey.*

Protection of Waterworks Operatives from Injurious Effects of Slaked Lime. H. LEHMANN and A. HELLER. Gas und Wasserfach, 75: 49, 967–970, December 3, 1932. Air contained 0.30 parts per million of calcium oxide when lime was emptied, without special ventilating arrangement, from paper bags through trap in floor, and produced discomfort to those in room. When closed, automatic bag-opening machine was used, with ventilating exhaust, air contained 0.07 parts per million of calcium oxide.—*W. G. Carey.*

Incrustations and Corrosion in the Water Mains of the Town of Schwenning. K. HERRMANN. Gas und Wasserfach, 75: 45, 890–893, November 5, 1932. Cast iron water mains distributing deep-well water after sand filtration were heavily incrusted with scale due to *Gallionella ferruginea*. Decay of algae produced hollow space between pipe wall and ferric oxide crust, and imperfections in asphalt covering of pipe led to pitting and graphitization. Scaling is minimised by high water velocity and better filtration.—*W. G. Carey.*

Natural Filters at Perth (Scotland). C. WALMESLEY. Water and Water Engineering, 35: 417, 237–242. April 20, 1933. Owing to increased pollution some old infiltration galleries constructed below level of River Tay have been abandoned, and new filter system installed comprising collecting culvert, laid in gravel bank parallel to river. Yield of over 3 million (Imp.) gallons per day is derived from river through perforations in side walls of ten 100 feet concrete galleries. Filtered water is dosed with 0.5 p.p m. of chlorine; no

chlorinous tastes are developed and residual chlorine disappears in 5 or 6 hours. With river level normal, water filters horizontally through 100 feet of sand and gravel and excellent results are obtained; when river rises, gravel bank containing filters may be submerged, water then filtering downwards through 10 or 12 feet of gravel and results are less satisfactory. Bacteriological tests show that with river below critical level, 97 to 99 percent of organisms are removed. Tables are given showing reduction of color, ammonia, oxygen absorbed, and nitrates.—*W. G. Carey.*

The Progress of Metafiltration. Anon. Chemistry and Industry, 52: 24, 499–501, June 16, 1933. Description of metafilter, designed by J. A. PICKARD (Transactions of Society of Chemical Industry 1930, 259 T–263 T) consisting of metallic strips flat on one side and bevelled towards edges on other side which also has central rib about one one-thousandth inch high. Another type consists of rings, instead of strips, with metasil (or kieselguhr) packing in V-shaped grooves formed by bevelling. Well water with 6000 bacteria per cc. showed, after filtration, 76.—*W. G. Carey.*

Determination of Copper and Lead in Potable Water. J. A. WIEGAND. Chem. Weekblad, 30: 262, 1933. From Chemistry and Industry, 52: 22, British Chemical Abstracts B., 446, June 2, 1933. Effect of ferric ions in colorimetric determination of lead and copper with sodium sulphide is not overcome by addition of phosphate. Satisfactory results are obtained after reduction to ferrous condition by boiling 90 cc. of sample with 10 cc. of 20 percent ammonium chloride, 2 percent of acetic acid, and 0.25 gram of hydrazine sulphate; the cooled solution is treated with 2 drops of 10 percent sodium sulphide in glycerine and color compared with standards.—*W. G. Carey.*

Removal of Color, Natural Gas, and Iron from Underground Water. W. H. MAXWELL. Water and Water Engineering, 35: 415, 118–120, March 20, 1933. Tunbridge Wells (England) has water supply faintly colored and cloudy, with strongly chalybeate character, containing also carbon dioxide and sulphurous and other gases. Water pumped from 407-foot borehole is coagulated with 0.93 grains per gallon of alumino-ferric and is then delivered to six oxidizing pressure filters with total capacity of 36,000 gallons (Imp.) per hour containing "polarite" which are also fitted with special aëration and spraying system, which releases gases. Treatment reduces carbon dioxide by half, and iron from 3.2 to 0.016 p.p.m. Resulting water is clear, colorless, and bacterially pure.—*W. G. Carey.*

The British Rainfall Organization. E. G. BILHAM. Water and Water Engineering, 35: 414, 61–64, February 20, 1933. Rainfall records have been kept since about 1860. The organization is a section of Meteorological Office and encourages making of reliable rainfall observations by private persons and local authorities; approximately 5,350 stations report daily or monthly readings. Charts showing rainfall distribution are published yearly; likewise evaporation and percolation records. Bibliography of papers relating to rainfall in British Isles is given in article.—*W. G. Carey.*

Determination of the Hardness of Water by the Clark Method. L'Industrie Chimique Belge, 1932, 439–447 and 481–487. Water and Water Engineering, 35: 413, 44, January 20, 1933. Differences between hardness as found by soap and as calculated from complete analysis occur because calcium and magnesium salts do not react with soap in equivalent proportions; differences may extend to several degrees, depending on nature and relative amounts of calcium and magnesium salts. Large amounts of free lime prevent use of soap method. Speed of soap addition and appearance of lather are important. Water of unknown hardness should be tested in several different dilutions.—*W. G. Carey.*

The Water Supply of Malaya. W. BUCHLER. Water and Water Engineering, 35: 415, 122–125, March 20, 1933. Formerly water was obtained from wells 5 to 10 feet deep, dug by manual labor; now there are about 100 public waterworks. Singapore is largest and obtains its water from five impounding reservoirs, mainly in jungle; water after filtration and chlorination is sold by meter. Biggest difficulty in building dams was prevalence of malaria; but now, by oiling stagnant water, no trouble is experienced. Penang's all-gravity supply receives no treatment. Singapore's bathing pools have continuous filtration and chlorination, and all domestic water fittings comply with British Waterworks Association specifications; but Chinese and Malays up-country depend on buckets and wells.—*W. G. Carey.*

Burgh of Grangemouth Water Supply. Anon. Water and Water Engineering, 35: 414, 64–66, February 20, 1933. Water from 450-million-gallon (Imp.) impounding reservoir being soft, slightly colored, and acid, is treated in four Candy rapid gravity filters, each with area of 280 square feet and capacity of 500,000 gallons (Imp.), using air-water wash. Fall of water 80 feet from reservoir to filters drives turbine generating all power required. Raw water is treated with 2 grains per gallon of aluminium sulphate and, after filtration, with 1 grain per gallon of lime as milk of lime, and, finally, with 3 pounds of chlorine per million gallons (Imp.).—*W. G. Carey.*

Controlling Stray Currents and Underground Corrosion. I. R. SMITH. Electrical Journal, 30: 11, 450, November, 1933. When current, returning to negative bus at power plant, leaves a water pipe, pitting and corrosion that ultimately destroy the pipe will occur. If low-resistance bond is provided between pipe and negative bus, the difficulty may be mitigated. Reverse currents, however, sometimes occur through this bond which cause trouble elsewhere. This latter difficulty can be overcome by use of polarized switch, or rectox rectifier, which permits flow of current in one direction only. Perhaps more important than effect of stray currents is corrosion due to galvanic or chemical action. If the iron potential could be made negative to the soil, current would not leave the pipe and hence corrosion would not take place. The rectox rectifier comes close to being the best available source of direct current which will accomplish this result. Bibliography on the subject follows the article.—*H. E. Babbitt.*

Drawdown-Capacity Curves for Water Wells. H. C. SCHWALEN. Civil Engineering, 4: 1, 10, January, 1934. Selection of economical pumping plant for deep drilled well requires in all cases some knowledge of drawndown-capacity curve of well in question. In most cases, however, data as to capacity of well are available for only one, or possibly two, test points. Often it is found impracticable to make preliminary capacity test at as high a rate of discharge as is desired in permanent pump installation. Test is made at only one rate of discharge, and, in estimating desired pump capacity, drawdown is assumed to be proportional to the discharge. Most engineers make an allowance for this deficiency in their data by adding to estimated drawdown some arbitrary amount as a factor of safety. Three cases have been selected in the article to illustrate relationship that exists between drawdown-capacity curve, type of well, and formation in which it is drilled. Only a few pumping tests are needed for the extrapolation of drawdown-capacity curves with reasonable accuracy, if engineer has the aid of the well-driller's log, a general knowledge of geology of locality, and familiarity with the usual shape of such curves.—*H. E. Babbitt.*

Seepage through Foundations and Embankments Studied by Glass Models. H. M. HILL. Civil Engineering, 4: 1, 32, January, 1934. Description of study of flow of water under dams on porous dams, by means of glass model.—*H. E. Babbitt.*

Sheboygan's New Four Million Gallon Elevated Reservoir. Anon. The Water Tower, 20: 3–4–5, page 4, January, 1934. Effect of tank on rate of pumpage and reduction of peak load. Structure consists of flat-bottomed steel tank 185 feet in diameter and 21 feet 7 inches high on circular concrete slab 196 feet in diameter. Slab is supported on piers 27 feet high.—*H. E. Babbitt.*

The Cause and Prevention of Calcium Sulphate Scale in Steam Boilers. F. G. STRAUB. Bulletin 261, Engineering Experiment Station, University of Illinois. October 24, 1933. Investigation was divided into five parts: (I) laboratory solubility studies, (II) laboratory experiments on the decomposition of sodium carbonate solutions, (III) scale formation in laboratory boiler, (IV) scale prevention in laboratory boiler, and (V) scale prevention in industrial power plants. Conclusions reached in the different parts are: (I) (*a*) solubility of calcium carbonate decreases with increase of temperature, (*b*) solubility of calcium carbonate in presence of sodium carbonate, or hydroxide is practically zero at temperatures studied, (*c*) solubility of calcium sulphate is not directly proportional to sulphate in solution, (*d*) calcium sulphate as a solid phase cannot exist in equilibrium with solutions containing over 30 p.p.m. of sodium carbonate, even at a pressure of 1,000 pounds per square inch, and (*e*) the old calculated ratios of CO_3:SO_4 to prevent calcium sulphate formation as a solid phase are extremely high. (II) (*a*) Principal controlling factor in establishment of extent of decomposition of sodium carbonate in boiler water is partial pressure of carbon dioxide in vapor phase: this, in turn, depends on amount and availability of potential carbon dioxide

contained in feedwater, (*b*) effect of boiler operating pressure decreases with decrease in carbonate content of feedwater, (*c*) for range of steaming rates covered in these tests, boiler rating does not appear to be a factor governing extent of decomposition, (*d*) total alkalinity existing in boiler water is a factor, extent of decomposition decreasing with increase in boiler-water alkalinity, (*e*) the decomposition phenomenon appears to take place in two steps as expressed by the following:

$$Na_2CO_3 + H_2O = NaOH + NaHCO_3$$
$$NaHCO_3 = NaOH + CO_2$$

(*f*) complete, or one-hundred-percent, decomposition cannot be attained even in the steaming boiler, and (*g*) usual boiler water analysis probably indicates less hydroxide than exists in boiler during operation. (III) (*a*) Rate of formation of calcium sulphate scale is almost constant at 150, 250, and 500 pounds pressure. At 1,000 pounds pressure, scale forms about one-third as fast as at 150 pounds, while at 2,000 pounds it forms only about one-tenth as fast as at 150 pounds, and (*b*) rate of formation of calcium sulphate scale appears to be independent of amount of calcium sulphate entering the boiler, and of amount of sludge (within reasonable limits) within the boiler. (IV) (*a*) Presence of more than 30 p.p.m. of sodium carbonate in boiler water will prevent formation of calcium sulphate scale at pressures up to 2,000 pounds per square inch, and (*b*) carbonate content necessary to prevent sulphate scale is independent of sulphate concentration within limits of concentrations carried in average high-pressure boiler. Some results of actual tests are given in tabulated form. —*H. E. Babbitt.*

Underground Corrosion of Ferrous Pipe. K. H. Logan. Civil Engineering, 4: 3, 128, March, 1934. Underground pipes in the United States have been estimated to have value of nearly six billion dollars and length of 450,000 miles. Annual loss, due to corrosion, in oil industry alone is $25,000,000. After pipe has been exposed for a number of years, rate of corrosion is materially reduced. When electrolytic theory of corrosion became generally accepted, first explanation offered for formation of pits in pipe surface was that of impurities in pipe material. However, when materials are buried in the ground, and under some other conditions as well, other causes of corrosion are more important. Importance of oxygen concentration was first realized in 1916. Since corrosion underground has been attributed to variations in supply of oxygen at different points along the line, an obvious way of preventing it is to secure uniform conditions with respect to oxygen. This can be done by deep burial and uniform, well-tamped backfill. Among methods suggested for reducing corrosion losses are use of copper and copper-alloy, which corrode less rapidly than ferrous materials; increasing thickness of pipe wall; and use of protective coatings. Purchaser of pipe coating should consider not only whether its fundamental properties are satisfactory, but also probability of getting it in the ground in satisfactory condition.—*H. E. Babbitt.*

Flow of Water through Sand. G. M. Fair. Civil Engineering, 4: 3, 137, March, 1934. Examination of fundamental equations for flow of liquids

through pipes and through sand will show that chief difference between the two equations is in the factors that describe the passageway through which the liquid flows. Among the different grain structures of sand are the following: (1) uniform sand; (2) non-uniform sand, non-stratified; (3) non-uniform sand, stratified with uniform voids; and (4) non-uniform sand, stratified with non-uniform voids. Three different groups of materials have so far been studied in the laboratory: (1) uniform sands; (2) glass spheres; and (3) non-uniform sands. There appears to be no reason why the formulas suggested should not apply to the flow of liquids other than water through materials other than sand.—*H. E. Babbitt.*

Filter Materials for Water and Sewage Works. Committee Report. Civil Engineering, 4: 3, 158, March, 1934. Brief report of progress of Committee's work with statement that final report will probably be made as soon as possible. —*H. E. Babbitt.*

World Progress in Water Supply Engineering. Committee Report. Civil Engineering, 4: 3, 162, March, 1934. Brief review of report of Committee on Water Supply Engineering. Following subjects are covered very briefly: cement, dam construction, pipe and pipe coatings, removal of tastes and odors from water, improved pumps and prime movers, new utilities accounting methods.—*H. E. Babbitt.*

Flow of Water around Bends in Pipes. D. L. Yarnell and F. A. Nagler. Proceedings Am. Soc. Civil Engineers, 60: 6, 783, August, 1934. Results of series of experiments with bends of various shapes and of various degrees of curvature in 6-inch pipe. The experiments show: (1) that in the same pipe bend, carrying identical quantities of water, it is possible so to vary conditions that resistance to flow may be either very small, or unusually large; (2) that in a standard 90-degree, 6-inch pipe bend, for the same quantity of flow, with high velocity on the inside, and low velocity on the outside, of approach pipe, loss of head may be four times as much as would be measured in same bend when high velocity exists on outside, and low velocity on inside of tangent leading to bend; (3) that present formulas for computing loss of head due to bends appear to apply only to cases in which approximately uniform velocity distribution exists in the approach pipe; (4) that losses of head in the bends experimented upon appear to vary as the square of the velocity, and not as the 2.25 power, as suggested by some writers; (5) that a pipe bend may be as useful as any other device for measurement of discharge; (6) that direction of flow of secondary currents in pipe bends depends entirely upon velocity distribution in approach pipe; and (7) that the same fundamental laws of flow apply both to closed conduits and to open channels, as to bends.—*H. E. Babbitt.*

Influence of Temperature on Coagulation. C. J. Velz. Civil Engineering, 4: 7, 345, July, 1934. Contrary to generally accepted view that chemical activity increases with rise in temperature, experiments in water treatment recently conducted in New Jersey show floc formation and color removal to be

retarded with rising temperatures. Floc formed more quickly when temperature of raw water was low, about from 2° to 14°C., being governed rather by electro-chemical than by chemical laws. At summer temperatures, larger dosages of coagulant were uniformly required to produce the same results. Analysis of such factors as hydrogen ion concentration, color of raw water, and others which are influenced by seasonal changes of temperature bore out strong positive correlation between temperature and dosage of coagulant required.—*H. E. Babbitt.*

Ware River Intake Shaft and Diversion Works. K. R. KENNISON. Civil Engineering, 4: 8, 388, August, 1934. Flood flows of Ware River are contributed to Boston's new Metropolitan Water Supply, through new tunnel, which is 260 feet below surface at point of diversion. When tunnel is finished, 3,100 cubic feet per second can be diverted, part to each of reservoirs. Under Massachusetts law, diversion is limited to flows in excess of 85 m.g.d.; that is, on any day when the flow is less than this, no water can be diverted. Diversion equipment, now completed, consists of dam 17 feet high, intake works, nine siphon spillways, and four butterfly valves in bottom of central well: it may be operated entirely automatically, so that siphons go into action whenever the river flow exceeds 85 m.g.d. Unique feature of shaft is its cast iron lining with helical vanes, which absorbs most of energy of falling water and prevents damage to shaft and tunnel. Present state of the work permits diversion to Wachuset Reservoir only. Amounts approaching 1,000 cubic feet per second have been successfully diverted to this reservoir.—*H. E. Babbitt.*

Bouquet Canyon Reservoir and Dams. H. A. VAN NORMAN. Civil Engineering, 4: 8, 393, August, 1934. To provide additional terminal storage for Owens River Aqueduct below the San Andreas fault, nearly three million cubic yards of earth and rock have been placed across the Bouquet Canyon, 50 miles north of Los Angeles to create reservoir with capacity of 38,000 acre-feet. Carefully selected, well-graded material was excavated from pit within reservoir area, and dumped, spread, and compacted with rollers of sheep's foot type, to form impervious part of barrier, which rises 221 feet above bedrock. The downstream, pervious section was built of material stripped from bedrock in the dam prism and adjacent to the abutments. On upstream face, reinforced concrete slab was placed and joined to concrete cut-off wall along upstream toe, which was carefully grouted as an additional precaution against leakage. Spillway is of vertical-shaft type, 163 feet deep and 8 feet in inside diameter, connected to tunnel of same diameter with an elbow of 16-foot radius. For upper 13 feet of its length, shaft is belled out from 8 feet to 16 feet at crest of spillway weir. To prevent the formation of vortex currents around top of weir shaft, a radial vane extends from one wall of shaft to the shore line. The gate-control tower, 136 feet in height, is constructed of reinforced concrete. It is circular in shape with a uniform outside diameter of 16 feet. Reinforced concrete pent house at top of tower provides housing for gate-operating equipment. Five cast-iron sluice gates, 42 by 60 inches, of conventional type, capable of resisting water pressure away from and towards their seats, control outflow from reservoir.—*H. E. Babbitt.*

Pumping Concrete for Dam Construction. E. W. SEEMAN. Civil Engineering, 4: 8, 398, August, 1934. Pump used to force concrete through pipe line in construction of Dam No. 5, on upper Mississippi River consists of reciprocating piston within cylinder equipped with suitable inlet and outlet ports. Concrete with slump of only 1½ inches was pumped through 7-inch pipes for distances of nearly 1,000 feet. Operation was continued throughout the winter, even when temperature was as low as 10 degrees below zero. The comparatively dry and harsh concrete handled by pump was vibrated in forms by aid of electrically-driven devices inserted in mass. Satisfactory strength of test cylinders and good quality of concrete in place attest to usefulness of this new type of concrete-placing equipment.—*H. E. Babbitt.*

Developing the Delaware River. M. J. YOUNG. Civil Engineering, 4: 8, 408, August, 1934. Résumé of War Department's report shows that hydroelectric power and domestic water supply are most important future uses for water of this river. Both head and storage are available for power; while additional domestic water supply will be needed in not far distant future by Philadelphia, northeastern New Jersey, and New York City. Inasmuch as Delaware River is an interstate stream, now being developed by conflicting interests, report recommends that major water supply and power developments should be coördinated, supervised, or controlled, by an interstate agency. Report has no direct connection with Delaware Diversion Case before U. S. Supreme Court, to which states of New York, New Jersey, and Pennsylvania were parties.—*H. E. Babbitt.*

Cash Versus Time Payments for Future Construction of Water Works Improvements and Additions. J. A. FULKMAN. Illinois Municipal Review, 13: 7, 137, July, 1934. Difficulty of obtaining favorable referendum votes on bond issues for water works improvements has been noticeable and, in many cities, thought is being directed towards accumulating reserves for future construction of water works improvements. Article is applicable to sections that do not have depreciation funds or sinking funds for future construction of water works. Three outstanding advantages of sinking fund method of financing are stated, and financial saving by cash-payment plan is demonstrated by means of an illustrative example.—*H. E. Babbitt.*

That Water Supply of Yours. W. D. GERBER. Illinois Municipal Review, 13: 7, 139, July, 1934. Subterranean and surface water resources in Illinois may be developed to aid in overcoming shortages in municipal supplies during such recurrent droughts as have been experienced in the recent past. Subterranean resources may be developed by means of wells of different types, each most suitable for some particular type of stratum. Surface supplies from Lake Michigan and from larger rivers of state have not been seriously endangered during droughts; but cities supplied from smaller bodies of surface water have approached, or passed, the danger line. Quality of both underground and surface waters is such that some form of treatment will assure their improvement.—*H. E. Babbitt.*

Winnetka's Municipal Electric and Water Utility. H. L. WOOLHEISER. Illinois Municipal Review, 13: 7, 143, July, 1934. Winnetka, with population of 12,500, is residential suburb of Chicago. It operates water and electric properties with book value of $2,156,000; delivering during 1933 a total of 657 million gallons of water and slightly more than 7 million kilowatt-hours of electrical energy, for combined gross revenue of $454,900, which was received from 3,307 consumers of electricity and 2,703 users of water. Utilities are operated on service-at-cost basis, as a business enterprise, without political interference.—*H. E. Babbitt.*

Keeping a Domestic Water Supply Safe. J. D. DE COSTA. Civil Engineering, 4: 9, 438, September, 1934. Water supply experiences of East Bay Municipal Utility District, on east shore of San Francisco Bay in California, show that governmental agencies are mostly concerned with bacterial safety, leaving physical appearance and general potability to water works official. Supply for District is entirely from surface sources and is filtered before distribution through four rapid sand filter plants with combined nominal capacity of 49 m.g.d., but supplying peak hourly maximum demand at rate of 200 m.g.d. Five lines of defense against contamination are (1) protection of source of supply, (2) long period of storage, (3) filtration, (4) sterilization, and (5) elimination of cross-connections. Average cost of operation of filter plants is $5.65 per million gallons treated, and cost of filtered water is about 29 cents per capita annually.—*H. E. Babbitt.*

Developing the Columbia River Drainage Basin. A Symposium. Civil Engineering, 4: 9, 443, September, 1934. Articles refer particularly to development of water power, irrigation, and navigation. **Aspects of the Problem in Canada.** J. C. MACDONALD. **Power and Navigation below the Snake River.** C. F. WILLIAMS. **Bonneville Power House and Equipment.** B. E. TORPEN. and **Columbia Basin and Grand Coulee Projects.** F. A. BANKS. First article outlines early history of region and describes Canadian part of watershed. The other three articles deal with purposes, plans, and construction methods contemplated for dams at Bonneville and the Grand Coulee.—*H. E. Babbitt.*

Flow in Bends of Quarter-Turn Draft Tubes. C. A. MOCKMORE. Civil Engineering, 4: 9, 460. The bend is where complications arise in function of velocity reductions: it marks the source of induced spiral flow. Odd-shaped bends, made of transparent pyralin, were used in the tests reported. One type of bend was found, in which loss of head was least. Use of pyralin for hydraulic tests was found most satisfactory.—*H. E. Babbitt.*

The Fort Peck Project. T. WYMAN, JR. Civil Engineering, 4: 9, 473, September, 1934. In northeastern Montana, a huge construction project that will cost $86,000,000 is now under way, to dam the upper reaches of the Missouri River and so equalize the flow as to minimize disastrous floods on the one hand and benefit low-water navigation for 800 miles along the lower river on the other. Geological as well as geographical conditions dominated the

choice of site and materials of construction. To obtain a crest height of about 250 feet above present river level, an earth-fill dam, 8,800 feet long, with average base width of 2,700 feet is needed, supplemented by over two miles of earth dike. Provisions for hydraulic sluicing, for by-passing the river, and for passing floods over the spillway are on a corresponding scale. It was even necessary to provide 285 miles of heavy electric transmission line exclusively for the job. As now contemplated, plan of operation provides for completion of project in five years.—*H. E. Babbitt.*

Treatment of Pacific Coast Water Supplies. J. A. WADE and K. W. BROWN. Civil Engineering, 4: 9, 478, September, 1934. As a rule these supplies contain no chemical constituents that cannot be satisfactorily handled by usual methods of treatment. Defects of common occurrence include undesirable tastes, or odors, unattractive appearance, and unpleasant hardness. Certain waters deposit encrustations in distributing pipes, thereby reducing their capacity: others, again, may even be extremely corrosive. Problems attacked include: removal of methane by aëration; chlorination to combat sulphur; removal of iron by sedimentation, aëration, filtration, and coagulation; softening of waters with hardness content as high as 2,500 p.p.m.; treatment of saline waters; removal of color and hydrogen sulfide from peaty water; removal of odor from swampy water; prevention of intrusion of salt water into wells; removal of carbon dioxide by aëration; and manganese removal.—*H. E. Babbitt.*

The Central Valley Project of California. E. HYATT. Civil Engineering, 4: 9, 482, September, 1934. Approximately three million acres of tillable land in Central Valley are traversed by Sacramento River from the south. Vast storage reservoirs and canal systems have been built to make the rainfall, which occurs in winter, available for summer use; but overdrafts on groundwater supplies are still required for both agricultural and domestic use, so that additional storage of winter flood waters is needed to provide adequate irrigation of area now under cultivation. After a complete inventory of water resources of state, a plan has been developed. The Central Valley Project contemplates a large reservoir of 3,000,000 acre-feet capacity at Kennett on the upper Sacramento River. This reservoir will provide flood protection in the winter, stop salt-water encroachment in lower reaches of river, and assure year-round navigation. By a system of canals, conduits, and pumping plants, excess water from reservoir will be made available to the orchard and farm lands of the San Joaquin Valley. This diversion from the Sacramento River will be augmented by water from the San Joaquin River stored behind a 250-foot dam at Friant. It is estimated that gross cost of $170,000,000 for Central Valley Project, when reduced by certain anticipated Federal appropriations, can be defrayed by sale of water and of hydro-electric power.—*H. E. Babbitt.*

California Cleans up Oil Pollution of Public Waters. C. W. GEIGER. Municipal Sanitation, 5: 9, 305–306, September, 1934. Oil refineries discharge large volumes of waste water containing oil. Purification problem is to cause the

oil to float, so that it may be skimmed off. In some cases oil in bulk has been permitted to escape with waste water. Improved reclamation systems, installed at enormous cost by refineries, make possible a waste water visibly free from signs of oil, to the great benefit of public water courses. Many oil fields are in natural drainage areas of public water supplies and, when closely grouped, present a difficult problem. In some cases legal action was necessary to effect a clean-up. In general, improvement is very noticeable. Coöperating with Bureau of Hydraulics, Water Waste Disposal Company of Orange County has completed a project for handling oil waste at an outlay of $500,000 and an annual maintenance cost of $50,000. With few exceptions, the oil industry organized itself to solve pollution problem, appointing a committee to establish standards and taking measures to meet the standards.—*R. E. Noble.*

Most Probable Numbers for Evaluation of Coli-Aërogenes Tests by Fermentation Tube Method. J. K. HOSKINS. Public Health Reports, **49**: 12, 393, March 23, 1934. Procedure is presented for computation of the most probable number of coli-aërogenes organisms present, from results of fermentation tube method of bacteriological analysis of water over a wide variety of combinations of portions of sample planted at various dilutions. Computed values are given in tabular form for the combinations of tubes most likely to occur in routine water, sewage, and milk analyses. All values given are correct to two significant figures.—*R. E. Noble.*

Recent Developments in Municipal Water Softening. A. S. BEHRMAN. Water Works and Sewerage, **81**: 8, 263–267, August, 1934. Discusses prevention of after-precipitation, numerous mechanical improvements introduced in lime-soda softening, municipal zeolite softening *vs.* lime-soda softening, and cost of zeolite water softening. Graph is given showing relationship between calcium carbonate in solution (alkalinity), free carbon dioxide, and pH values. —*R. E. Noble.*

Algae Growth Raises pH of Water. W. C. EMIGH. Water Works and Sewerage, **81**: 8, 275–276, August, 1934. Discusses influence of algae on pH value of raw water, with chart showing pH rising between copper sulphate treatments, and receding following treatments, at Coatesville reservoir; also, effects of reservoir overturn and of addition of copper sulphate on algae multiplication; also, sharp rise in pH and alkalinity following sudden six-degree temperature drop of surface water in same reservoir.—*R. E. Noble.*

Damage to Water Works at Bridgeton, N. J., Closes Factories. Water Works and Sewerage, **81**: 8, 276, August, 1934. Floods damaged pumping station and filtration plant, necessitating use of wells for domestic requirements. Factories employing 2500 people shut down. Federal financial assistance was sought, to restore normal water service. Manufacturers suggested that polluted water be pumped into water mains, with notification to consumers to boil the water used for drinking; but city authorities refused.—*R. E. Noble.*

Certain Statutory Provisions as to Pollution of Waters Construed. Public Health Reports, 49: 3, 100. January 19, 1934. (Texas Court of Civil Appeals; TURNER, et al. *v* Big Lake Oil Co., et al., 62 S. W. (2d) 491; decided June 29, 1933.) Article 698 mentioned "any watercourse or other public body of water" while chapter 42 mentioned "any stream, watercourse, or natural body of water of this State." Civil appeals court held that former referred to public, and not to private, bodies of water. Respecting chapter 42, court opined that "natural body of water of this State" referred to waters owned by State in trust, and not to waters privately owned.—*R. E. Noble.*

NEW BOOKS

A Simple Formula for Estimating the Height of Capillary Rise in a Granular Deposit. YASHICHI YOSHIDA. Monograph published and distributed by author from Kumamoto Technical College, Kumamoto, Japan. 1934. Following formula is developed:—

$$h = 3\,\frac{T_t}{T_{10}}\left[\frac{1}{k\ (0.75 + 0.25\mu)\ d_w}\right] = 3\,\frac{T_t}{T_{10}}\left[\frac{1}{kd}\right]$$

in which h = capillary rise in cm.; T_t = surface tension in dynes at t°C.; T_{10} = surface tension in dynes at 10°C.; d = YOSHIDA'S, or true, effective size; k = a constant dependent upon the porosity, value of which varies between 0.274 for porosity of 26 percent and 0.435 for porosity of 46 percent; μ = uniformity coefficient of the granular deposit; and d_w = HAZEN'S effective size, in mm.—*H. E. Babbitt.*

The Summary of the Studies on the Collection Wells and Galleries as Sources of Water Supplies. YASHICHI YOSHIDA. Monograph published and distributed by the author from Kumamoto Technical College, Kumamoto, Japan. 1934. This book of 96 pages is an intensive study of the theory and principles of underground flow. It contains chapters on the flow of water through sand, gravel, stone, and clayey materials and on the hydraulic study of slow sand filtration and the natural filtration of infiltration galleries constructed in river beds and in lake beds. Second part of the monograph is devoted to mathematical analysis of flow of water into wells and galleries. Treatment of the subject is thorough and exhaustive, and formulas are presented for a large number of different types of wells and filter galleries, and of conditions of underground flow.—*H. E. Babbitt.*

Proceedings, Thirteenth Texas Water Works Short School, Waco, Texas, January 20–23, 1931. 6 x 9 inches. 137 pp. **Message from G. H. Fenkell, President, American Water Works Association.** 7, 8. **Minutes and Summarized Proceedings.** 9–20. **The Valley of Mexico.** ANASTASIO GUZMAN. 21–26. History of sanitation in Mexico from the time of the Aztecs until the present. **The Rehabilitation of a Small Water Purification Plant.** A. M. BRENNEKE. 26–30. Denison, Texas, improves its plant by adding chlorination, an inspirator-mixer, and a settling basin. **The Dallas Filter Plant.** L. C. BILLINGS. 30–33. Description of improvements completed in 1930,

including Garza dam and reservoir, intake, low-service pumping station, aërator, mixing basin, preliminary sedimentation basin, secondary reaction chamber, and filters. **Private Cross-Connections.** JOEL L. CONNOLLY. 33–38. Discussion of hazardous arrangements of plumbing, endangering safety of water supplies, with particular emphasis upon hospitals. **The Feasibility of Lining Water Storage Reservoirs with Gunite.** W. O. BOWER. 38–45. Experience at Port Arthur, Texas, in lining an open 150-m.g. reservoir, and some difficulties encountered therein. **Recent Observations on Pipe Linings and Pipe Coefficients.** ALEXANDER POTTER. 46–51. The coefficient of friction is important in considering the value of lining. Cement lining, centrifugally applied, should have thickness of $\frac{1}{16}$ inch for 4- and 6-inch pipes, $\frac{1}{8}$ inch for 8-, 10-, 12-, and 16-inch pipes, and $\frac{3}{16}$ inch for 18-, 20-, and 24-inch pipes. Bitumastic enamel lining, centrifugally applied, should be about $\frac{3}{32}$ inch thick, and of a consistency to withstand the range in temperature to which pipe will be subjected. **The Therapeutic Value of Mineral Waters.** N. D. BUIE and T. G. GLASS. 51–56. Therapeutic waters include: simple thermal waters, principally employed as baths; common salt waters, having a limited medical use; alkaline waters, containing sodium bicarbonate; bitter waters, containing chiefly magnesium sulphate; chalybeate waters, containing iron in medicinal quantities; calcareous waters, containing calcium and magnesium carbonates and sulphates; sulphur waters; and arsenical waters; the therapeutic values of which are attributed to the principal active constituents. Description and analysis of the mineral waters of Marlin, Texas. **Summary of Part I of the Trinity River Reclamation Report.** B. F. WILLIAMS. 56–59. Notwithstanding abandonment of project by War Department in 1922, recent studies conclude that flood control and canalization project is now feasible. **Some Notes and Comments on Water Purification Cost Data.** H. N. OLD. 59–63. Investment costs of rapid sand filtration plants, not including real estate, run from $15,000 to $50,000 per m.g.d. capacity; operating costs, from $6 to $12 per m.g. output. Investment costs of softening plants, from $30,000 to $60,000 per m.g.d.; operating costs, from $10 to $20 per m.g. per 100 p.p.m. of hardness removed. Investment costs of iron removal plants, from $30,000 to $50,000 per m.g.d.; operating costs, from $13 to $21 per m.g. Water purification by the ordinary municipal filtration plant costs each consumer about 55 cents per year. **Economics of Filter Plant Operation.** C. E. TROWBRIDGE. 63–66. Thorough understanding of the processes employed and constant vigilance to secure efficiency are essential to economical and satisfactory operation. **Experimental Work and New Practices in the Field of Water Purification during 1930.** J. N. HINYARD and E. P. SCHOCH. 67–72. Advances in mixing, coagulation, use of sodium aluminate, preliminary treatment for filtration, filter sand specifications, chlorination, and use of activated carbon. **Cheap and Dependable Methods of Chlorination.** H. J. PARDEE. 72–78. Discussion of problems involved in application of liquid chlorine, with particular emphasis on temperature conditions. **Factors Affecting the ortho-Tolidine Test.** E. W. STEEL. 79–80. Extremely low or high temperatures, sunlight, nitrites, or iron or manganese in solution interfere with determination of excess chlorine by this method. **Permissible Culture Media.** I. M. LEWIS. 80–82. Lactose peptone broth is

standard for the presumptive test; Endo's agar and eosine methylene blue agar, for the confirmed test. **Some Non-standard Media for Use in Water Bacteriology.** O. B. WILLIAMS. 82–84. Brilliant green bile, gentian violet, and crystal violet are favored by some workers. **The Advantages of Combined Mixing and Aëration.** HERMAN ANDERSON. 84–89. Benefits shown by operating results at Frankfort, Ky., and Waukegan, Ill. **Sodium Aluminate in the Treatment of Water.** C. M. BARDWELL. 89–93. Use of sodium aluminate in industrial lime and soda ash softening enables hardness to be reduced to one grain per gallon with no considerable excess treatment. Solutions of sodium aluminate are being developed for use in internal boiler water treatment. **The Dallas, Texas, Sewage Treatment Plant.** S. W. FREESE and M. C. NICHOLS. 90–93. **Recent Observations in Water and Sewage Treatment Research.** F. E. GIESECKE. 94–99. Description of the utilization of the Ruhr River (Germany) for both water supply and sewage disposal on a self-liquidating basis. **Waco's Water and Sewage Purification Works.** S. R. WRIGHT and C. C. HAYS. 99–103. Description of both plants, with tables of operating results. **Standard Sewage Tests made at the Waco Activated Sludge Plant.** B. A. BASSEL. 104. **Unique Features of the Tyler Sewage Treatment Plant.** L. H. POWELL. 105–106. **Automatic Control for Mechanically Cleaned Bar Screens.** FRANK BACHMANN. 107–111. **The Efficiency of the Dunbar Sewage Filter in Practical Operation.** R. G. UPTONN. 111–113. **Odor Control Experiments by the Application of the Vacuum Degasification Process and the Use of Chlorine at the Cleburne, Texas, Sewage Disposal Plant.** C. C. HAYS. 114. **Report of Stream Pollution Committee, Texas Section, Southwestern Water Works Association.** 115–117. **Status of Municipal Sanitary Improvements in Texas.** 119–137.—*R. L. McNamee.*

Southwest Water Works Journal, Vol. 15, No. 12, 1933. State Department of Health Program in Relation to Public Water Supplies. JOHN W. BROWN. 14–15. System for appraisal of municipal water supplies and fire protection, at least as desirable as that in use by Fire Insurance Commission. It brings out weak points in system, stimulates sanitary improvements, and favors the trained operator. **Public Relations: Intangible Asset, or Liability?** JOE J. MURRAY. 18–20. General discussion of principles adhered to at Dallas, Texas. **Considerations in Establishing Water Rates.** N. T. VEATCH. 21, 22. Rate structure for water service is a problem essentially individual and requiring special study. Comparison with existing rates in similar cities is probably the worst method of attacking the problem.—*O. M. Smith.*

Southwest Water Works Journal, Vol. 16, No. 2, 1934. Geology of Arbuckle Mountains, Oklahoma, as to Water Supply. CHARLES E. DECKER. 9–10. Most streams from these mountains in southern Oklahoma have suitable dam sites for lakes of considerable size. To the north, in Dougherty basin, are good potential artesian conditions. **Transite Pipe Water Lines.** F. B. HOLGATE. 11, 12. General discussion. **Study of the Water Resources of Arkansas.** JOHN H. GARDINER. 13. Actual developments of water power total 94,530 h.p.; potential developments, 527,800 h.p. Recital of studies made by U. S. Geological Survey. **Experiences in the Operation of the Water**

Softening Plant at Lawrence, Kansas. C. T. HOUGH. 15. In recarbonation, careful attention should be paid to the pH at temperatures of 34° to 37°F. Treated water has total hardness of 80 to 110 p.p.m. and a pH of 8.4 to 8.8. (*Courtesy Chem. Abst.*)—*O. M. Smith.*

Southwest Water Works Journal, Vol. 16, No. 3, 1934. The Application of Powdered Activated Carbon in Purifying Public Water Supplies. JOHN P. HARRIS. 11–16. Excellent illustrated survey of method of application and of results obtained. Objectionable tastes and odors from beet sugar waste at Dundee, Mich., were more economically removed by "Nuchar" powdered carbon than by granular carbon filter. (*Courtesy Chem. Abst.*) **Ground Water Supplies of Kansas.** KENNETH K. LANDES. 17, 24–26. Brief description of geology of bed rock and mantle rock supplies. Emphasizes the advisability of intelligent survey under direction of a geologist.—*O. M. Smith.*

Southwest Water Works Journal, Vol. 16, No. 4, 1934. The Selection of Source of Domestic Water Supply. M. Z. BLAIR. 18, 19. Plea for necessary exploratory and experimental studies before final design for project is prepared. **Fluorides in Water and Their Relation to Mottled Enamel.** SELMA GOTTLIEB. 24. General discussion. (*Courtesy Chem. Abst.*)—*O. M. Smith.*

Southwest Water Works Journal, Vol. 16, No. 5, 1934. Water Rates and City Finance in Some Arkansas Cities. H. W. BLALOCK. 9–11. Of 16 cities whose water plant financing was studied, 3 received contributions from the plants and 8 made contributions to the plants. Detailed tabulation is given. **Internal Combustion Engines.** GERRY BADER. 13–15, 20–23. Excellent discussion of suitability from cost and service standpoints of the various sizes and types of Diesel engines for water works service.—*O. M. Smith.*

Proceedings Fourth Annual Meeting Kentucky-Tennessee Section, American Water Works Association, Chattanooga, January 24–26, 1929. 64 pp. **The State Health Department and the Water Works Operator.** Dr. E. L. BISHOP. 1–3. Plea for coöperation between Health Department and Water Works operating personnel. **Federal Requirements for Water Supplies Used on Interstate Carriers.** H. N. OLD. 4–9. General discussion on U. S. Treasury Dept. Standards for drinking and culinary water supplied by common carriers in Interstate traffic. These standards are applied and administered with care and in sympathetic coöperation with state and local health authorities. **A State Health Department View of the Stream Pollution Problem.** ROY J. MORTON. 10–14. Plea for reasonable administration of stream pollution control agencies, for fair allocation of burden of remedial measures as between contributor of pollution and subsequent user of stream and for close coöperation with, and assistance to, industries related to the problem. **Water Works Requirement for Fire Protection.** E. T. HOLMAN. 15–24. Requirements for fire protection affect the small plant in much greater degree than the large plant. Use of Fire Department pumpers and strengthening of distribution system is considered better practice than raising pressures over the entire system during period of fire demand. **Industries and Public Water Supplies.**

WELLINGTON DONALDSON. 24–28. Objectionable industrial wastes affecting public water supplies may be classed as:—(*a*) wastes which can be, but are not, handled by adequate water treatment; (*b*) wastes not susceptible to elimination by water treatment; (*c*) wastes which, because of variation in rate or quality, constitute a potential hazard; and (*d*) wastes that impose additional financial burdens upon water treatment, as by increasing the hardness. In the case of wastes of first class, remedy is with water treatment; in second case, needs of industry must be subordinated to public convenience and welfare; in third and fourth cases, close coöperation between industry and water user is essential. **Corrosion from a Water Works Viewpoint.** J. W. MCAMIS. 29–34. Well-stated elementary discussion of electro-chemical theory of corrosion and of correction of corrosion by protection of metal with deposit of $CaCO_3$. **Water Meter Practice.** R. C. WARKMAN. 34–36. Discussion of the location, installation, maintenance, and testing of service meters. **Rate Making for Water Works System.** 37–40. Water rate structure should be non-discriminatory and well-balanced as between several classes of users and the amount of water allowed in each step of the rate schedule. **State Sanitary Engineer, Water Works Operator, and Consulting Engineer.** C. N. HARRUB. 41–45. Mutual confidence, respect, and coöperation should mark the relations between these three officers. **Appraisal of Water Works Properties.** H. F. WIEDEMAN. 46–50. Various methods of evaluation of physical valuation, intangible values, and depression, are discussed in general terms. **Responsibility of Water Companies for Fire Protection.** ROBERT M. BORDEN. 50–55. Indefinite contract stipulation relative to private water companies' responsibility for fire protection has resulted in court decisions against the companies. Contract terms based upon N.B.F.U. rating schedule will be equitable as between municipalities and companies. Water company should not be charged with losses due to inefficient operation of hydrants. **Pumping and Filtration Cost.** W. S. DAVIS. 56–58. Detailed description of water supply system comprising river intake, low-service pumping plant, coagulation and filtration plant and high-service pumping plant at location unnamed [probably Harriman, Tennessee.—ABSTR.]. **Conservation by Metering.** F. R. VANNOY. 59–61. Change from flat rate basis to complete metering has resulted in general satisfaction to customers, increase in water receipts, and marked conservation of water. **The Place of Technically Trained Men in the Water Works Business.** H. K. BELL. 62–64. Problem of water supply is one of engineering and all plants, however small, will benefit from application of engineering principles in design, operation, and management.—*R. L. McNamee.*